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U. S. DEPARTMENT OF
AGRICULTURE
FARMERS' BULLETIN No. 1723

FEEDING,
CARE, AND MANAGEMENT
of young
DAIRY STOCK



THE sure road to the development of a high-producing dairy herd is the raising of strong, healthy calves that have an inheritance for high milk and butterfat production.

Breed the cows in the herd to a registered dairy bull whose breeding is such as to insure the maximum probability of his transmitting to his progeny the hereditary factors that will determine a high level of production.

Give the pregnant cow and newborn calf the proper feeding and care.

Give the growing calf suitable feed and care so that it will develop properly.

Cleanliness is essential in all the details of feeding and care.

Feed whole milk for the first 2 to 4 weeks of the calf's life. After that the feed can be gradually changed to fresh skim milk; or to any one of a number of milk products, or to a special calf meal. Calves make good use of milk or milk products up to 6 months or more of age.

Besides milk, the calf also needs a good quality of hay cured so as to retain its natural green color and most of its leaves, and a suitable grain mixture, to insure getting all the required nutrients, including minerals and vitamins.

Heifers over 6 months of age require an abundance of pasture in summer, and hay or hay and silage in winter, with sufficient grain in addition, to supply the nutrients for normal growth.

Dry, clean, well-bedded, and well-ventilated quarters free from drafts are required for dairy calves. Older heifers can be housed in a shed open to the south.

All ailments and diseases require prompt and proper treatment. Cleanliness is one of the best disease preventatives.

These and other points essential to raising good dairy stock are discussed in the following pages.

This bulletin supersedes Farmers' Bulletin 1336, Feeding, Care, and Management of Dairy Calves and Young Dairy Stock; Leaflet 20, Care of the Dairy Calf; and Leaflet 14, Raising the Dairy Heifer.

Washington, D. C. Issued April 1934. Revised March 1940.

Slightly revised March 1952.

FEEDING, CARE, AND MANAGEMENT OF YOUNG DAIRY STOCK

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RAISING CALVES FOR HERD REPLACEMENTS

THE maintenance of a herd of high-producing dairy cows calls for the raising, for replacement purposes, of healthy, well-grown calves that have an inheritance for a high level of milk and butter-fat production. To breed such calves healthy, high-producing cows should be mated with a carefully selected, registered dairy bull of good conformation, whose breeding is such as to insure the maximum probability for his transmitting the hereditary factors for high production to his offspring.

The feeding for proper growth and development of the dairy calf begins before it is born. The pregnant cow should be given sufficient feed so that she will be in fair to good flesh at calving time, and the ration fed should be adequate in vitamins, minerals, and protein. Cows fed rations greatly deficient in these important substances may give birth to weak, puny calves that are hard to raise. A strong, vigorous calf is more likely than a weak calf to respond normally to proper feeding and care, and to develop into a large-sized animal capable of producing up to its inherited capacity.

¹ Resigned May 31, 1937.

CARE OF THE FRESHENING COW

Cows freshen normally about 270 to 290 days after breeding. The majority freshen within 275 to 285 days, with an average of about 280 days. Where accurate breeding records have been kept, the date of freshening can be calculated to within 1 to 10 days. This makes it possible to dry the cow off at the right time and give her the proper feeding and care during the dry period and at calving time.

Several days before the calf is due to arrive, separate the cow from the rest of the herd and place her in the calving quarters. During cold weather this should be a roomy, well-bedded box stall that has been thoroughly cleaned and disinfected. Keep the box stall clean and well-bedded, so that when the calf arrives it will be dropped in a clean, dry place. A small, well-grassed plot or pasture free from trash or manure and close to the barn makes a good calving place in summer.

The first indications of approaching calving are a pronounced swelling and enlarging of the vulva and a dropping away or sunken condition on either side of the tail setting. When these signs are noted, the cow should not be disturbed, but her condition should be observed from time to time. If everything is progressing normally, she will usually give birth to her calf without any assistance. Proper assistance should be given to the cow or to the calf if it is required. Such assistance may prevent the loss of a calf.

Detailed information regarding the feeding and management of the dry cow and care of the cow at calving time is contained in Farmers' Bulletin 1470, Care and Management of Dairy Cows.

CARE OF THE NEWBORN CALF

Immediately after it arrives, the calf should be given attention. Remove any membrane or mucus from its mouth and nostrils. If the calf lies motionless and does not start breathing promptly, try to help start respiration by slapping the chest vigorously or by the alternate compression and relaxation of the chest.

The cow in normal condition is much concerned with the welfare of her calf, and usually begins to dry the calf at once by licking it vigorously. If she does not, or if the air is cold and damp, rub the calf dry with burlap or some other suitable material.

The newborn calf is very susceptible to disease germs. These may gain entrance through the navel or the digestive tract. To guard against navel infection, apply tincture of iodine to the navel at birth and dust with boric acid powder. If a long cord is attached to the navel, clip it off about 2 inches from the body before applying the iodine. The naval cord should not be tied but allowed to drain freely to encourage shrinkage and healing.

Be careful to keep the box stall clean and well-bedded while the calf remains with the cow, in order to lessen the danger of infection by contamination with filth.

A normal calf is able to stand shortly after birth, and within half an hour it may be nursing. If the cow's udder is soiled, there is danger of the calf being infected from this source. Wash the udder with warm water and soap, and rub dry at once with a clean cloth. Sometimes the calf is so weak that it must be held up to the cow's udder to help it get started to nurse. If it does not suck at first, milk a small stream of milk into its mouth. If the weak calf cannot be induced to

suck by this method, try feeding it warm milk from its mother in a bottle, either with or without a nipple.

Be certain that the calf gets one or more good feeds of the first milk, or colostrum. This milk is different in composition from normal milk (p. 10). It helps to clear out the digestive system and protects the newborn calf against infection from harmful bacteria gaining entrance through the digestive system. Colostrum seems essential for the development of normal immunity in the calf. Experiments to determine the effect of withholding colostrum milk from calves show that where it is not fed, many calves die from the effects of infection from harmful bacteria.

If the cow and the calf are both progressing normally, the calf should not be left with the cow longer than 12 hours. When this period has elapsed it is best to remove the calf, because it is harder to teach a calf to drink when left too long with its dam than one removed soon after birth. Also, the longer a calf is left with its dam, the more the cow and calf will worry when they are separated.

QUARTERS FOR THE YOUNG CALF

When the calf is taken from its dam, place it in a small individual pen by itself where it cannot be jostled around or the calf injured by being sucked by other calves. A separate pen will also make it easier to feed and care for the calf and note its condition of health.

The pen should be light and well-ventilated but free from drafts and not too cold. It should be thoroughly cleaned and disinfected before the calf is placed in it and kept well-bedded with dry material. Cold drafts and cold, damp pens are frequent causes of diarrhea, colds, and pneumonia.

Raised floors made of wire or perforated metal have proved helpful in the raising of young calves, and the use of such floors for this purpose is becoming quite common. This type of floor, when covered with 3 to 4 inches of long straw or other long bedding, provides a warm, dry bed for the calf and lessens the danger of colds, pneumonia, and some types of scours. The calf pen should be equipped with a gutter or drain so that liquid will not accumulate underneath. The raised floor should be movable so that it can be lifted or removed when necessary for cleaning and disinfecting.

To disinfect the calf pen, scrape off any manure remaining on the floor or walls, and scrub them thoroughly with hot water or an alkaline washing powder. When the floor and walls are clean, apply a suitable disinfectant to them with a spray pump, forcing the disinfectant into all small cracks and openings. Disinfectants and the disinfection of stables are discussed in detail in *Farmers' Bulletin 954, The Disinfection of Stables*.

In order to keep the calf from licking other calves or objects outside the pen, the sides should have no open spaces and should be at least 3½ feet high. This helps to protect the calf from disease germs and may also aid in preventing the spread of disease to other young calves. Figure 1 shows individual pens for young calves. A temporary individual pen is shown in figure 2.

Raised floors made of heavy metal similar to expanded metal lath can be purchased from commercial concerns. Raised floors can also be made at home by fastening heavy wire cloth (No. 11 or heavier wire woven with a ¼-inch mesh and galvanized after weaving) to a

rigid wooden frame. The frame should be made of 2- by 6-inch or 4- by 4-inch material. It will also be best to place No. 9 wire (at 4- to 5-inch intervals in both directions) or heavy woven-wire fencing under the wire cloth to prevent it from sagging.

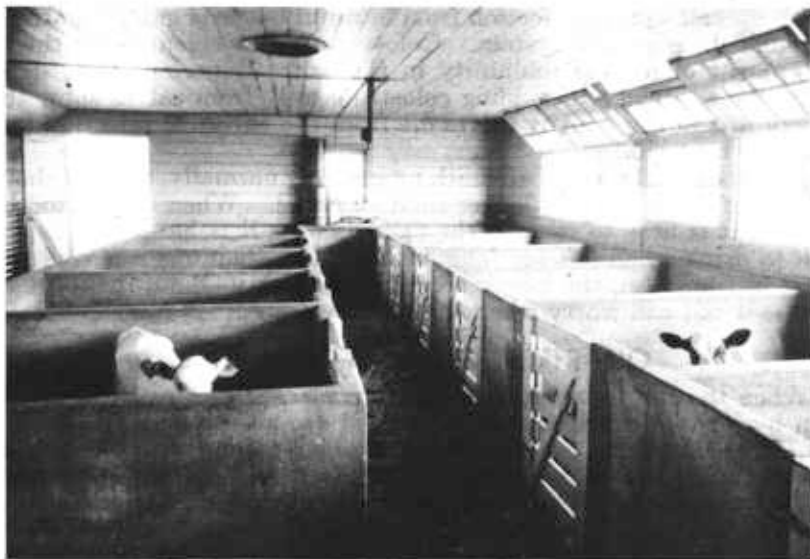


FIGURE 1.—Individual pens for young calves, experimental dairy farm, Beltsville, Md., Bureau of Dairy Industry.



FIGURE 2.—Temporary pen, made from three solid wood panels, for the young calf.

The pen should be equipped with a small box for grain and a small slatted rack for hay, as the calf will be learning to eat these feeds before it is placed with other calves.

By the time the calf is 3 or 4 weeks old its navel has healed, and it has gained in strength and vigor. It can then be placed in a larger pen with other calves of about the same age. This pen should be

equipped with stanchions (figs. 3 and 4), which permit each calf to feed individually without interference from other calves, and a slatted rack conveniently placed so that the calves can eat hay at any time when not confined in their stanchions. At this age the



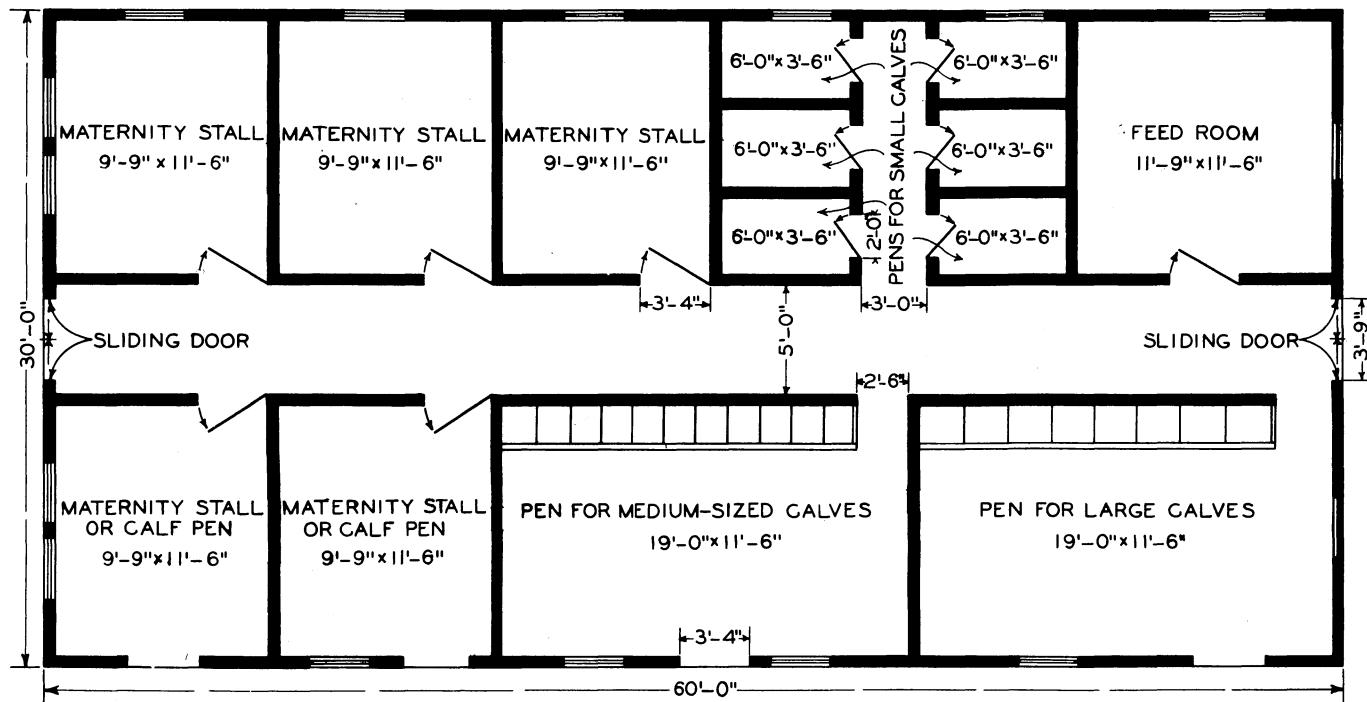
FIGURE 3.—Home-made calf stanchions and mangers.



FIGURE 4.—Steel calf stanchions and mangers.

calves should also have access to a well-drained lot or small pasture, where they can be turned out to get exercise and direct sunlight when it is not too cold or stormy.

The floor plan of a well-arranged maternity and calf barn is shown in figure 5.



CLEANLINESS IN FEEDING AND CARE

Calf diseases and many disturbances of the stomach and digestive system are caused by harmful bacteria which multiply in filth and dirt. Thorough cleanliness is absolutely essential in the successful raising of calves. This is equally true of the feed, pens, bedding, and the pails and other utensils.

All milk fed should be fresh and clean. All other feeds should also be fresh and wholesome. Keep the calf pens clean and well-bedded with dry material. Remove all discarded feed from the feed boxes every day. After each feeding thoroughly wash and scald or steam the pails, cans, and other utensils used in feeding milk or gruel to calves. If heating equipment is not available, use chlorine solutions, and place the utensils on a drying rack in direct sunlight after they have been washed and treated, so that they will dry rapidly.

Milk from cows infected with a communicable disease such as tuberculosis and Bang's disease (infectious abortion), and skim milk, buttermilk, or whey from a creamery or cheese factory should always be pasteurized before being fed because it is impossible to know whether such products are free from bacteria that cause disease.

Creameries and cheese factories usually pasteurize such products before making them available for feeding purposes. If they have not been pasteurized, they should be heated on the farm to 150° F. and held at this temperature for 30 minutes, or heated to 180° and cooled immediately.

TEACHING THE CALF TO DRINK

After the calf has been taken from its dam, do not feed it for at least 12 hours. It will then be hungry and can usually be taught to drink quite readily. A calf being taught to drink should always be handled gently.

For the first feeding place a quart of fresh warm milk from the dam in a clean pail. Hold the pail of milk on the floor in front of the calf, taking care to keep as far away from the calf as possible. The normal calf will nose around the pail, and will often begin to suck up or drink the milk of its own accord. If it does not, dip two fingers in the milk and place them in the calf's mouth. If the calf will not suck the fingers, raise its head, open its mouth, and pour in a teaspoonful of milk, taking care that the calf does not get any milk into its lungs, and then try again. When the calf has started to suck the fingers eagerly, draw the hand slowly down into the milk. Spread the fingers slightly and the calf will draw milk into its mouth between the fingers as it sucks. After it has had several swallows remove the fingers. At this point the calf may continue to drink, or it may raise its head, and the foregoing procedure may have to be repeated several times.

Usually the calf will move around and butt the pail vigorously in its effort to get the milk. To restrain the calf and avoid spilled milk, it may be necessary to back the calf into a corner and straddle it before offering it milk. Then if the calf refuses to lower its head into the pail, the head can be forced down gently.

If the calf does not learn to drink at the first feeding, do not feed it again until it is hungry.

FEEDING CALVES DURING THE FIRST 2 TO 4 WEEKS

The proper feeding of the dairy calf during the first month of its life is of the greatest importance. Since its digestive system is easily upset, the calf will thrive better at this time if it is fed sparingly rather than too much. Also, precautions are necessary in hand feeding that are not required when the calf takes its food in a natural manner.

In order to get a good start, the average strong, vigorous calf should be fed whole milk for at least 2 weeks; then the whole milk may be gradually replaced by fresh skim milk, other milk products, or specially prepared calf meals. If the calf is weak, or if it is especially valuable, feed whole milk 3 or 4 weeks before making any change.

During the first week feed fresh, warm milk from the calf's dam. Afterwards mixed milk from the herd can be used.

If the calf is weak, it may be desirable to feed small quantities of milk three times a day for a week or two, after which twice a day will be sufficient. Strong calves will usually do about as well if fed only twice a day from the start.

QUANTITY OF WHOLE MILK TO FEED

The quantity of whole milk to feed will depend on the size and condition of the calf. In attempting to grow a good calf, too often the tendency is to feed too much milk at the start. As a consequence the calf gets indigestion and scours and does not thrive as well as if it had received a smaller quantity. Never feed the strong, vigorous calf more than 1 pound of milk per day for each 10 pounds of live weight, during the first 7 days. Feed small, sick, or weak calves smaller quantities, according to their condition.

Data on the birth weight of dairy calves collected by a number of agricultural experiment stations throughout the United States indicate that the average weight at birth of calves of the principal dairy breeds is approximately as follows: Jerseys, 55 pounds; Guernseys, 65; Ayrshires, 70; Holsteins, 90; and Brown Swiss, 95. The smallest calves weigh considerably less and the largest calves considerably more than these average figures. Male calves weigh a little more than female calves, and purebred Holstein-Friesian and Brown Swiss calves are heavier on an average than grade calves of these breeds.

The following quantities of milk per day will be sufficient at the start for average-sized, vigorous calves of the different breeds:

	<i>Pounds</i>
Jersey	5
Guernsey	6
Ayrshire	7
Holstein-Friesian	8
Brown Swiss	8

Large and vigorous calves may be safely fed 1 or 2 pounds per day more than the quantities indicated. Small calves and calves that are weak or sickly should receive smaller quantities, according to their condition. If it is necessary to reduce greatly the quantity of milk fed, the calf may not get sufficient liquid to supply its needs for water. In such cases, add enough warm water to make up for the reduction in the quantity of milk.

To avoid indigestion and scours, feed the calf at regular hours. Calves allowed to become too hungry between feedings will often

take their food in gulps, with the result that acute indigestion, bloat, diarrhea, or even death may follow.

Carefully regulate the quantity of milk and feed it at a temperature of 90° to 100° F. Use a scale and weigh the milk at each feeding (fig. 6). If a scale is not available, use a pint or quart measure and measure the quantity very closely. For feeding purposes, consider 1 pint as 1 pound, and 1 quart as 2 pounds.



FIGURE 6.—Weighing milk for the calf.

Too rich milk may give the calf indigestion and scours. If the milk tests more than 4 percent of butterfat, dilute it with a little warm water or skim milk at each feeding.

ADDING LIMEWATER TO MILK

Until the calf is 3 or 4 weeks old, the addition of one-half pint of limewater to the whole milk at each feeding appears to be beneficial. The hand-fed calf drinks milk rapidly, and limewater will help prevent the milk from forming into a hard curd that cannot be readily digested by weak or sickly calves.

Limewater may be made from either unslaked lime (lump lime) or commercial hydrated lime (common plaster lime, usually sold in paper bags). To make limewater from unslaked lime, place a lump about

the size of an egg in the bottom of a pail of water. When this has slaked, stir vigorously. When using commercial hydrated lime, stir 2 ounces or so into a bucket of water and mix thoroughly several times at short intervals. In either case allow the lime to settle and use only the clear solution. When this supply is gone, use fresh lime in making up a new batch.

METHOD OF FEEDING AT BELTSVILLE

A large number of Jersey and Holstein calves are raised each year at the experiment station at Beltsville, Md. They are taken from their dams when about 12 hours old and are fed twice a day from the start. Whole milk is fed for the first 30 days, and then a change is gradually made to skim-milk feeding. The quantities of milk fed are as follows:

Jersey calves receive 2 pounds of whole milk and one-half pint of limewater per feed for the first 10 days; 2½ or 3 pounds of whole milk per feed for the second 10 days; and 4 to 5 pounds of whole milk per feed for the third 10 days, depending on the size and condition of the calf.

Holstein calves receive 4 pounds of whole milk and one-half pint of limewater per feed for the first 10 days; 5 pounds of whole milk per feed for the second 10 days; and 6 pounds of whole milk per feed for the third 10 days.

Calves that are weak or sickly are fed considerably smaller quantities of milk until their condition improves and they are able to digest normal quantities.

FEEDING CALVES FROM 1 TO 6 MONTHS OF AGE

DIFFERENT METHODS OF FEEDING

After the calf has received a good start on whole milk, it will grow and develop satisfactorily on a number of different feeds if their quality is good and feeding conditions are carefully controlled.

TABLE 1.—Average composition and total digestible nutrients of normal whole milk, colostrum, fresh skim milk, fresh buttermilk, fresh whey, dried skim milk, dried buttermilk, and condensed buttermilk

Product	Total dry matter	Mineral matter	Protein	Carbo-hydrates	Fat	Total digestible nutrients
	Percent	Percent	Percent	Percent	Percent	Percent
Normal whole milk	12.8	0.7	3.5	4.9	3.7	16.2
Colostrum	25.5	1.6	17.6	2.7	3.6	27.0
Fresh skim milk	9.6	.8	3.7	5.0	.1	8.6
Fresh buttermilk	9.4	.8	3.5	4.5	.6	9.1
Fresh whey (from American cheese)	6.6	.7	.9	5.0	.3	6.4
Fresh whey (skimmed)	6.6	.7	.9	5.0	.03	5.4
Dried skim milk	93.8	8.0	34.8	50.1	.9	84.1
Dried buttermilk	92.2	10.5	33.8	41.9	5.6	85.5
Condensed buttermilk	29.9	3.7	11.3	13.3	1.6	27.3

Data from Feeds and Feeding, 1936 edition, except those for colostrum, which are from Missouri Research Bulletin 35, A Study of the Birth Weight of Cows.

A few breeders of dairy cattle continue whole-milk feeding, but whole milk is usually too valuable to feed to calves of this age. Calves do nearly as well on fresh skim milk, and where it is available most calves are raised on this feed. On farms where whole milk is sold and fresh skim milk is not available, a number of other milk products can be fed. If a creamery or cheese factory is located nearby, it may be possible to obtain fresh buttermilk or fresh whey of a high quality

suitable for calf feeding. If the fresh products cannot be obtained, it is usually possible to purchase dried skim milk, dried buttermilk, or condensed buttermilk for this purpose.

The choice of a milk product for calf feeding depends not only on its availability and quality, but also on its relative cost per unit of total digestible nutrients contained. The average chemical composition and digestible nutrient content of normal whole milk, colostrum milk, fresh skim milk, fresh buttermilk, fresh whey, dried skim milk, dried buttermilk, and condensed buttermilk are given in table 1.

The relative value of these feeds (excepting colostrum milk) based on the total digestible nutrients contained in comparison with fresh skim milk priced at \$0.20 to \$0.60 per 100 pounds is shown in table 2.

TABLE 2.—*Ratio of total digestible nutrients and value per 100 pounds for feed, of normal whole milk, fresh buttermilk, fresh whey, dried skim milk, dried buttermilk, and condensed buttermilk as compared with those of fresh skim milk*

Product	Total digestible nutrients as compared with skim milk		Value per 100 pounds for feed as compared with 100 pounds of fresh skim milk priced at—				
			20 cents	30 cents	40 cents	50 cents	60 cents
	Percent	Ratio	Dollars	Dollars	Dollars	Dollars	Dollars
Fresh skim milk.....	8.6	1.00	0.20	0.30	0.40	0.50	0.60
Normal whole milk.....	16.2	1.88	.38	.56	.76	.94	1.13
Fresh buttermilk.....	9.4	1.06	.21	.32	.42	.53	.64
Fresh whey (from American cheese).....	6.4	.71	.14	.21	.28	.36	.43
Fresh whey (skimmed).....	5.4	.63	.13	.19	.25	.32	.38
Dried skim milk.....	84.1	9.78	1.96	2.93	3.91	4.89	5.86
Dried buttermilk.....	85.5	9.94	1.99	2.98	3.98	4.97	5.96
Condensed buttermilk.....	27.3	3.17	.63	.95	1.27	1.59	1.90

Beginning at about 2 weeks of age, the calf requires hay of good quality and a suitable grain mixture to supplement these feeds. It also requires a plentiful supply of pure water at an early age.

Where milk or milk products are not too high in cost, it is best to continue feeding them until the calf is about 6 months of age. At this time the calf should be eating large enough quantities of other feeds so that its growth will not be retarded to any appreciable extent.

When the cost of feeding milk or milk products is excessive, they may be gradually discontinued after the calf is 2 to 3 months old.

Usually such calves will not gain so rapidly or be as thrifty at 6 months of age as calves fed milk.

If dried milk products are fed, these can either be fed in a liquid form with water added or fed dry mixed with a special grain mixture or calf meal. This latter method of calf feeding is discussed under Special Dry-fed Calf Meals (p. 19). Dried blood flour and fish meal are sometimes used as an ingredient of such feeds.

Under some circumstances it may be practical to raise calves on whole milk from a nurse cow.

Recent experiments indicate that calves which are normal and healthy at birth can be raised on fresh or dried skim milk after the 3-day colostrum period by giving them cod-liver oil along with the skim milk.

Dairy calves to be disposed of for veal usually make the best grade of veal if fed whole milk until slaughtered. This subject is discussed under Feeding Dairy Calves for Veal (p. 34).

FRESH SKIM MILK

If the calf is doing well, gradually substitute fresh skim milk for whole milk when the animal is 2 to 4 weeks old. Take at least 10 days to make the change, substituting skim milk for the whole milk at the rate of about 1 pound a day. Do not increase the total quantity of milk fed while this change is being made. If the calf has scours (diarrhea) the milk is not being properly digested. Delay any further substitution of skim milk for whole milk until this condition disappears. It may be necessary to give the calf a purgative and reduce the quantity of milk fed. The treatment for scours is discussed under Scours from Indigestion (p. 39).

Feed fresh warm skim milk direct from the separator if possible. If the skim milk is not fed soon after being separated, warm it to about 95° F. before feeding. Feeding dirty milk or milk alternately sweet and sour or warm and cold may bring on indigestion and scours. If the feeding is carefully supervised, milk that is uniformly cold or sour can be fed successfully after the calf is 2 to 3 months of age. However, some calves may have a tendency to scour on such milk, and it is best to make a practice of feeding only warm, sweet skim milk. In feeding skim milk, take care to remove the foam as this sometimes causes digestive trouble and bloating.

After the change from whole milk to skim milk has been made, the quantity of skim milk fed can be increased by 1 pound daily every week or by 2 pounds daily every 2 weeks until the calf is getting the maximum quantity it is to be fed. If skim milk is plentiful, Jersey, Guernsey, and Ayrshire calves should be fed from 12 to 14 pounds and Holstein and Brown Swiss calves from 14 to 16 pounds daily. These quantities of milk, with 3 pounds of grain daily and all the hay of good quality the calf will eat, will be sufficient for growth at about a normal rate. If hay is of the best quality and very palatable, the calf will eat more hay and can make normal gains to 6 months of age with the above quantities of milk and not more than 2 pounds of grain daily.

Where additional skim milk is available, large calves can be fed 17 to 20 pounds or even more to advantage and can be raised on a minimum amount of grain or with no grain at all. The calf getting no grain will not be as large or thrifty looking at 6 months as the calf getting some grain. Where skim milk is scarce, calves can be raised on as little as 10 pounds daily. To obtain near normal growth to 6 months with this quantity of skim milk will require the feeding of at least 3 pounds of grain daily with good roughage, or 4 pounds daily with roughage of ordinary quality.

After the calf is 6 months old it can grow and develop normally without skim milk. However, if additional skim milk is available and extra-good growth is desired, calves can be fed skim milk to advantage to 8, 10, or even 12 months of age. Where skim milk is scarce, skim-milk feeding can be discontinued at as early as 2, 3, or 4 months of age if roughage of the best quality is fed and at least 4 pounds of grain daily between weaning time and 6 months of age. Calves receiving skim milk to only 50 or 60 days of age should be fed as outlined under special dry-fed grain mixtures or calf meal.

FRESH BUTTERMILK OR FRESH WHEY

Buttermilk or whey to be suitable for calf feeding should be strictly fresh and should not be diluted by wash water nor to any appreciable extent by condensed steam. They should also be pasteurized and hauled to the farm and fed while still fresh and wholesome. Unless the above conditions can be met, these products will not be desirable calf feeds.

Fresh buttermilk has practically the same composition as fresh skim milk but contains a small amount of fat. It is higher in acidity except possibly when sweet-cream butter is manufactured. If fresh buttermilk is of good quality and properly fed it will give about as good results as fresh skim milk. Fresh buttermilk may be somewhat more laxative than fresh skim milk, and it will usually be best not to change from whole milk to this feed until the calf is 3 to 4 weeks old. The change should be made very gradually to avoid digestive disturbances. The quantities of fresh buttermilk to feed, method of feeding, and supplementary feeds are the same as for fresh skim milk.

Fresh whey lacks not only the fat but also most of the proteins contained in whole milk and has only about two-thirds of the feeding value of an equal weight of fresh skim milk. In addition, it is somewhat laxative. When this feed is properly supplemented with a high quality of legume hay and with a grain mixture which is high in protein, the calf will be thrifty and make a fairly good rate of growth. For best results the calf should be given a good start on whole milk, and not changed over to fresh whey until it is 4 or 5 weeks old. The quantity fed should be gradually increased until the calf is receiving a maximum of 14 to 16 pounds daily. At the Wisconsin Agricultural Experiment Station calves were fed a maximum of 14 pounds of fresh whey per day together with clover hay and a grain mixture consisting of 300 pounds of ground corn, 300 pounds of standard wheat middlings, and 400 pounds of linseed meal. An average daily gain of 1.48 pounds each was made by these calves as compared with 1.52 pounds by calves fed fresh skim milk limited to 10 pounds daily and 1.76 pounds by calves given a maximum of 14 pounds of fresh skim milk daily.

DRIED SKIM MILK, DRIED BUTTERMILK, OR CONDENSED BUTTERMILK

Dried skim milk, dried buttermilk, or condensed buttermilk differ from the fresh products only in having most or part of the water removed through heating and evaporation. Because of this lower water content, approximately 1 pound of dried skim milk, 1 pound of dried buttermilk, or 3 pounds of condensed buttermilk have the same feeding value as 10 pounds of the fresh products. Dried skim milk and dried buttermilk have a low-moisture content. They are shipped in either paper-lined barrels or bags and will keep indefinitely if stored in a dry place. In the production of condensed buttermilk, only part of the water is removed, leaving the material in a semisolid or heavy liquid form. This product is shipped in sealed barrels or cans and will keep indefinitely in the sealed container, and can be fed without loss from mold if an even layer is removed from the entire surface each day.

Feeding trials at a number of State agricultural experiment stations indicate that calves will grow nearly as well on dried skim milk or dried buttermilk reconstituted to the approximate composition of fresh skim milk or fresh buttermilk as they will on an equal weight of the fresh product. However, as a rule calves do not do quite as well on reconstituted semisolid buttermilk as on fresh or reconstituted dried skim milk or buttermilk. When the dried products can be obtained they are to be preferred to the semisolid products.

The calf may be fed the reconstituted dried skim milk beginning at 2 to 4 weeks of age. The feeding of reconstituted dried or condensed buttermilk should be delayed until the calf is 3 to 4 weeks old as these feeds may be somewhat more laxative than the dried skim milk. The change from the feeding of whole milk to the reconstituted products should be made gradually, in the same way, and using the same quantities as recommended for fresh skim milk. The method of feeding and supplementary feeds are the same as for fresh skim milk.

If the calves have a tendency to scour, add one-half pint of lime water at each feeding until this condition is remedied. Directions for making lime water are given on page 9.

To prepare the dried skim milk or dried buttermilk for feeding, mix one part of the dried product to a smooth paste with an equal weight of warm water. When the lumps have all broken up, add eight more parts by weight of warm water and stir thoroughly.

To prepare the condensed buttermilk for feeding, add seven parts by weight of warm water to three parts of condensed buttermilk and stir until well mixed. For best results, mix with the same proportion of water from day to day and feed at a temperature of about 95° F. Only enough should be mixed at one time for one feeding.

Where these products do not cost too much they can be fed in the same quantities as fresh skim milk until the calf is 4 to 6 months old. If the cost of such products is too high, the calf can be weaned at 50 to 60 days of age and placed on a good grain mixture or a good dry-fed calf meal containing dried skim milk or some other animal product.

RAISING CALVES ON A NURSE COW

In some cases it may be practicable to raise calves on a nurse cow. Hard-milking cows, low producers, low testers, cows with pendulous udders, or kicking cows may often be used as foster mothers. One cow can handle from two to four calves, depending on the quantity of milk being produced, and may raise several sets of calves during a lactation period.

Calves raised on a nurse cow are less trouble to feed and usually thrive better than those raised by other methods. They will gain according to the quantity of milk obtained. Each calf should receive the first milk or colostrum from its dam before being placed on a nurse cow. It should not be allowed to get too much milk at the start and normally can be raised on 8 or 10 pounds a day. If it keeps in good condition and does not get the scours from overeating, it can be assumed to be properly nourished.

The calves are often allowed to run with the nurse cow. However, it is easier to regulate the feed of the cow and of the calves if they are kept in a separate pen or lot except at nursing time. The cow should be turned in with them two or three times a day until they are between 1 and 2 months old, and then once a day until they are weaned.

When the calves are 2 weeks old they should have access to good hay, all they will eat of a dry-fed grain mixture or calf meal, and plenty of pure water. They can be weaned between 60 to 90 days of age and handled like any other calf being raised on grain or calf meals.

RAISING CALVES WITHOUT WHOLE MILK AFTER 3 DAYS

In nutrition experiments at Beltsville, the Bureau of Dairy Industry during the last 5 years has successfully raised heifer calves without whole milk after the calf was 3 or 4 days old by feeding fresh skim milk supplemented with cod-liver oil to supply vitamin A. At first 20 cubic centimeters (4 teaspoonfuls) of cod-liver oil was fed daily. Later, 10 cubic centimeters (2 teaspoonfuls) of cod-liver oil was found to supply enough vitamin A, and nearly as good results were obtained by feeding 7 ounces (about 1 cupful) of finely grated carrots per day in place of the cod-liver oil. The vitamin A supplements can be safely omitted at 60 to 90 days of age, when the calf should be eating 1 or 2 pounds of early-cut leafy hay with plenty of green color.

Calves fed in this manner received more skim milk than the quantity of whole milk usually recommended but did not gain quite so fast as calves started on whole milk. However, they gained rapidly later on, and at 6 months of age could not be distinguished from calves started on whole milk.

The usual grade of cod-liver oil for animal feeding that was used in raising these calves can be obtained at \$0.50 to \$1 or more a gallon. One gallon contains 189 20-cubic centimeter doses or 378 10-cubic centimeter doses if no allowance is made for loss in pouring. On the basis of 150 doses of 20 cubic centimeters each per gallon, the cost of cod-liver oil would be one-third to two-thirds of a cent per calf daily. On the basis of 300 doses of 10 cubic centimeters each per gallon it would be one-sixth to one-third of a cent. If the hay fed is of the best quality, the smaller dose will be ample. If the hay fed is of ordinary or poor quality, it would be best to give the larger dose.

HAY AND GRAIN

The calf requires hay and grain at an early age to supplement milk in order to grow and develop normally. These should be fed as soon as the calf can be induced to eat them, usually at about 10 days to 2 weeks of age. A handful of the most palatable hay on hand should be placed in a rack where the calf can reach it conveniently but cannot soil it. Until the calf is eating hay readily, a fresh supply should be provided each day in order to tempt its appetite. The calf can be taught to eat grain by rubbing a little on its muzzle and placing a handful in the bottom of the pail after it has finished drinking its milk.

Hay used for feeding young calves should be cut before it gets too mature and handled during curing so as to retain its green color and most of its leaves. Such hay will be high in protein, assimilable minerals, particularly calcium, and vitamin A. Sun-cured hay will also be a good source of vitamin D, while artificially dried hay will be low in this vitamin.

Legume hays or grass hays cut before the blossom stage will usually be the highest in these constituents and the most suitable for calf feeding. The calf can also be safely fed principally on artificially

dried hay if it gets plenty of sunshine and is fed a little sun-cured hay; otherwise, a vitamin D supplement will be required.

The calf should have as much good hay as it will eat at all times. Where alfalfa hay is fed, the calf should not be given hay which is extra leafy and extra palatable during the first few weeks. It may overeat on such hay and get indigestion and scours. The quantity of hay consumed will depend not only on the palatability of the hay, but also on the quantity of other feeds consumed. Ordinarily, the calf will be eating 1 pound or a little more of hay daily at 2 months of age, $2\frac{1}{2}$ to 3 pounds daily at 3 months, and 5 to 6 pounds daily at 6 months. A calf at 6 months of age may eat considerably more hay than this amount if the hay is extra palatable, or if it is limited to 2 or 3 pounds of grain with milk and hay, or if it is being raised on grain or grain and calf meal without milk. For example, at the Nevada station Holstein heifers at 6 months of age ate an average of 13 pounds of hay per day per head when fed skim milk and one-half pound of grain and allowed access to good alfalfa hay from an outside rack at will.

The grain fed to dairy calves should be palatable and provide the energy, protein, and minerals required for normal growth that are not provided in the milk and hay. The farm grains (corn, oats, barley, kafir, and milo) and the protein concentrates (wheat bran, linseed meal, and soybean meal) are all suitable feeds for the young calf. Cottonseed meal may also be fed in limited quantities. The protein concentrates contain more minerals as well as more protein than the farm grains. Wheat bran and linseed meal are particularly good sources of phosphorus.

The percentage of protein needed in the grain mixture will depend on the ration fed. When the calf is getting moderate or liberal quantities of skim milk or buttermilk along with a leafy legume hay or early-cut grass or mixed hay the grain fed can consist entirely of farm grains. A grain mixture containing 14 to 16 percent of total protein may be needed by calves fed limited quantities of skim milk or buttermilk with good hay. A grain mixture containing as much as 18 to 20 percent of total protein may be required by calves fed whey or fed grain as a substitute for milk, with good hay. Where the hay and grain are home-grown and the soils of the locality are known to be low in phosphorus, it is best to include wheat bran or 1 percent by weight of bonemeal in such a mixture. Suitable grain mixtures are as follows:

Grain mixtures containing 10 to 12 percent of total protein:

A		B		C		D	
	Pounds		Pounds		Pounds		Pounds
Corn alone or oats alone.		Corn.....	10	Corn.....	30	Corn.....	20
		Oats.....	10	Wheat bran.....	10	Oats.....	20
						Wheat bran.....	10

Grain mixtures containing 14 to 16 percent of total protein:

E		F		G		H	
	Pounds		Pounds		Pounds		Pounds
Corn.....	20	Corn.....	30	Corn.....	30	Corn.....	30
Oats.....	20	Wheat bran.....	10	Oats.....	10	Oats.....	30
Linseed meal.....	10	Linseed meal.....	10	Wheat bran.....	10	Wheat bran.....	30
				Linseed meal.....	10	Linseed meal.....	10

Grain mixtures containing 18 to 20 percent of total protein:

I		J		K		L	
	Pounds		Pounds		Pounds		Pounds
Corn.....	10	Corn.....	20	Corn.....	10	Corn.....	20
Oats.....	20	Wheat bran.....	10	Oats.....	10	Oats.....	20
Linseed meal.....	10	Linseed meal.....	10	Wheat bran.....	10	Wheat bran.....	10
				Linseed meal.....	10	Linseed meal.....	20

In all these grain mixtures, barley, kafir, milo, or hominy feed may replace part or all of the corn; soybean meal may replace part or all of the linseed meal. Cottonseed meal may replace one-half of the linseed meal until the calf is 6 months old and may replace either half or all of the linseed meal for older calves. Young calves seem to prefer whole corn or oats to ground corn or oats at first, and calves will do about as well up to 4 or 5 months of age on the whole grain as the ground grain. After the calf is 4 or 5 months old, the corn should be ground and the oats either ground or rolled. Kafir and milo should be ground and barley either ground or rolled for calves of all ages.

A calf 2 weeks old will eat only a small handful of grain a day. Calves being fed liberal quantities of milk will eat about a half pound daily at 4 weeks, 1 pound at 6 weeks, $1\frac{1}{2}$ pounds at 8 weeks, and 2 pounds at 10 weeks to 3 months of age. This will be enough grain if milk is fed liberally to 6 months of age along with the best quality of legume or mixed hay. When milk is fed in limited quantities or discontinued at an earlier age or a poor grade of hay is fed, it may be necessary to feed 3, 4, or even 5 pounds of grain a day, including any calf meal.

WATER

The calf should be supplied regularly with fresh, pure water. Soon after the calf has learned to drink, it can be readily induced to drink water from its pail immediately after finishing its milk. An experiment at the Idaho Agricultural Experiment Station showed the amounts of water that calves drank when fed milk to the age of 6 months in quantities of 12 to 16 pounds per calf per day. The average daily consumption of water was 0.01 pound at 3 weeks of age, 2.19 at 8 weeks, 12.91 at 16 weeks, and 25.23 pounds at 24 weeks. In another experiment calves were fed 12 pounds of milk per day from birth to 5 weeks of age, and then the milk ration was gradually replaced during the sixth to the eighth week by a dry-fed grain mixture. These calves each drank 0.56 pound of water daily at 3 weeks, 11.26 pounds at 8 weeks, 27.09 at 16 weeks, and 38.96 at 24 weeks of age. The total amount of water consumed, including that in the feed, was about the same for calves of the same age and body weight that were raised by different methods.

During warm weather a lack of water may make calves uncomfortable and slow down their feed consumption and rate of growth. At the Wisconsin station a calf-feeding experiment was conducted in warm weather in which one group of calves was watered twice daily, while the calves in another group received no water. Both groups of calves received 14 pounds of skim milk per calf daily and were fed all the hay and grain they would eat. The calves receiving water drank somewhat more water than milk, ate twice as much hay and nearly one-third more grain, and made a daily gain of 1.80 pounds on an average as compared with only 1.36 pounds for the calves receiving no water.

Calves old enough to run together should be supplied with an abundance of pure water. This can be provided from a conveniently located water trough or from a drinking cup.

SPECIAL DRY-FED GRAIN MIXTURES AND CALF MEALS AS SUBSTITUTES FOR MILK

Where skim milk or other milk products are scarce or high in price, the calf can be raised by feeding limited quantities of milk and gradually substituting a good grain mixture or calf meal for milk at an early age. Some calves are fed calf meals mixed with water in the form of a gruel. However, the calf can be raised with less labor and less trouble from scours if the calf meal is fed dry. Calves raised in this manner do not gain as rapidly or look as thrifty as calves fed liberal quantities of fresh skim milk, and are sometimes more difficult to raise. However, if given good care and attention and a good start on milk, such calves may make a satisfactory growth.

Experiments have indicated that calves can be raised on as little as 150 pounds of whole milk, including colostrum, with no milk after 30 days. However, taking milk away at this early age severely retards the growth of the calf for a while since its digestive system has not developed to the point where it can digest large quantities of hay and grain. Feeding milk in limited quantities to 50 or 60 days results in giving the calf a better start as it is eating larger quantities of hay and grain by the time milk feeding is eliminated. During this period the calf can be fed on whole milk, on whole milk and fresh or reconstituted skim milk, or it can be raised on a nurse cow. Not more than 325 to 400 pounds of whole milk, or 150 to 200 pounds of whole milk and 400 to 600 pounds of skim milk, will be required for this period of milk feeding. Small and weak calves require milk for a longer period of time and ordinarily should not be raised on limited milk feeding.

Grain Mixtures

A grain mixture used as a substitute for milk should be composed of palatable feeds and have a protein content of not less than 16 to 18 percent. Since the nutrients in grain are not as suitable for growth as the nutrients in milk, the growth of the calf will be retarded somewhat between 2 and 4 months of age. However, the calf may grow more rapidly from 4 months on and with good feeding and care may reach a normal weight when 6 months old or shortly thereafter.

At the State agricultural experiment stations mentioned calves fed either legume hay or mixed grass and legume hay for roughage have attained a normal or nearly normal live weight at 6 months of age on the following grain mixtures:

Wisconsin:

Corn, 25 percent; oats, 25 percent; wheat bran, 25 percent; linseed meal, 25 percent (protein, 18 percent).

New Jersey:

Corn, 25 percent; oats, 37.5 percent; wheat bran, 12.5 percent; linseed meal, 25 percent (protein, 17.6 percent).

Maryland and Ohio:

Corn, 28.6 percent; oats, 28.6 percent; wheat bran, 28.6 percent; linseed meal, 14.2 percent (protein, 16 percent).

South Carolina:

Corn, 40 percent; oats, 40 percent; cottonseed meal (41-percent protein grade), 20 percent (protein, 17.3 percent).

Calf Meals

Dry-fed calf meals or calf starters consist of a good grain mixture with the addition of protein from some animal source and a protein content of 20 percent or more. On a good calf meal the calf, as a rule, will maintain a better rate of growth following weaning from milk than it will on an ordinary grain mixture. With good feeding, calves should be average or a little above average in weight at 6 months.

Animal products which have been used in calf meals include dried skim milk, dried buttermilk, soluble blood flour, ordinary blood meal, dry-rendered tankage, and fish meal. Dried skim milk provides the best possible source of animal protein for a calf meal. Twenty percent of this product will give about as good results as larger quantities. Dried buttermilk which is of uniformly good quality and not too acid can also be used, but may not give quite as good results as dried skim milk. Soluble blood meal or flour is an unpalatable product; however, if calves can be induced to eat the blood meal in large enough quantities it will make about as good growth on this product as on dried skim milk. In a recent experiment at the Ohio station ordinary blood meal and dry-rendered tankage have given about as good results as dried skim milk or soluble blood flour. Fish meal has given good results in some experiments but has proved unsatisfactory in others. Only the best grades of fish meal, processed from fresh fish residues into a wholesome product low in moisture and fat, are suitable for calf feeding. As a rule, products such as fish meal, dried blood flour, blood meal, and dry-rendered tankage are better suited to supplement dried skim milk in a calf meal than for use as the sole source of animal protein.

The following calf meal, composed of easily obtainable ingredients, is not far different in composition from calf meals containing dried skim milk on which calves have made the best growth at several State agricultural experiment stations:

	Percent
Ground yellow corn.....	30
Crushed or rolled oats.....	30
Wheat bran.....	10
Linseed meal.....	10
Dried skim milk.....	20

The ingredients used in this mixture can be varied somewhat to meet conditions on individual farms. Oatmeal without the hulls will give a little better results than ordinary oats. White corn will be about as good as yellow corn. Ground or rolled barley can be used to replace part or all of the ground corn. Ten percent of soybean meal, cottonseed meal (41- or 43-percent protein grade), soluble blood flour, dried blood meal, dry-rendered tankage, or a high-grade fish meal can be used to replace the linseed meal or one-half of the dried skim milk.

At the South Carolina station calves made slightly better than normal growth to 6 months on a simple calf meal consisting of 35 percent of ground yellow corn, 35 percent of ground oats, 20 percent of cottonseed meal (41-percent protein grade) and 10 percent of dried skim milk.

From 0.5 to 1.0 percent of salt should be added to grain mixtures and calf meals. Finely ground, steamed bonemeal and ground limestone are also added to some calf meals at the same rate. These may be helpful if the hay fed is not a legume or if the hay is not of the best quality.

At the New York (Cornell) Agricultural Experiment Station it was found that a good calf meal containing 20 percent of dried skim milk gave better results when supplemented with small quantities of white fish meal and cod-liver oil in addition to mineral supplements. This calf feed, called a reinforced calf starter, is made up as follows:

	Percent		Percent
Ground yellow corn.....	32. 25	Dried skim milk.....	20. 00
Rolled oats (oatmeal).....	28. 00	Salt.....	. 50
Wheat bran.....	10. 00	Ground limestone.....	. 50
Linseed meal.....	5. 00	Steamed bonemeal.....	. 50
White fish meal.....	3. 00	Reinforced cod-liver oil.....	. 25

In the above mixture, 0.5 to 1.0 percent of cod-liver oil of the usual animal-feeding grade can be substituted for the fortified cod-liver oil. In grain mixtures of this kind, cod-liver oil is known to lose most of its vitamin A potency within a short time, and the best way to give the cod-liver oil is to mix 2 to 4 teaspoonfuls in the feed of each calf every day.

In more recent experiments at that station the addition of either dried brewers' yeast or a cereal yeast feed to a dry calf starter resulted in a more rapid growth and the total digestible nutrient requirement per unit of gain in weight was a little lower than without yeast. When 6 percent of dried brewers' yeast was used to supplement 20 percent of dried skim milk in the calf meal, or 5 percent of cereal yeast feed and 5 percent of soybean meal was used to replace one-half of the dried skim milk, the improvement in growth was nearly as great as when 16 percent of cereal yeast feed was used to replace one-half of the dried skim milk. The increased efficiency of the improved calf meal was thought to be due to the vitamin B factor in the yeast.

However, in an earlier experiment at the Minnesota station no benefit was derived from feeding yeast to young calves being fed fresh milk in normal quantities or to older calves.

There are several ready-mixed calf meals or calf starters on the market. The best ones contain one or more animal products and will give about as good results as a good home-mixed calf meal. Some of these have been compressed into pellet form. In feeding experiments at the Idaho and New York (Cornell) stations calves fed a calf meal in pellet form did not make any better growth than calves fed a calf meal in the usual form.

Directions for Feeding Calf Meals

In the following paragraphs are suggested the approximate amounts of milk to be fed to calves that are to be raised on a calf meal and fed limited amounts of milk until 7 to 9 weeks old. Warm water is added as the quantity of milk is decreased so that the calves will not suffer from a lack of water until they are accustomed to drinking from the regular supply.

Limited whole milk:

Feed Holstein and Brown Swiss calves 8 pounds of whole milk a day until they are 1 week old, 9 pounds of whole milk daily during the second week, 10 pounds of whole milk daily during the third week, 8 pounds of whole milk and 2 pounds of warm water daily during the fourth week, 6 pounds of whole milk and 4 pounds of warm water daily during the fifth week, 4 pounds of whole milk and 6 pounds of warm water daily during the sixth week, and 2 pounds of whole milk and 8 pounds of warm water daily during the seventh week, with all warm water and no milk beginning with the eighth week.

Feed Ayrshire, Jersey, and Guernsey calves 6 pounds of whole milk a day until they are 1 week old, 7 pounds of whole milk daily during the second week, 8 pounds of whole milk daily during the third to sixth weeks, 6 pounds of whole milk and 2 pounds of warm water daily during the seventh week, 4 pounds of whole milk and 4 pounds of warm water daily during the eighth week, and 2 pounds of whole milk and 6 pounds of warm water daily during the ninth week, with all warm water and no milk beginning with the tenth week.

Limited whole milk and skim milk:

Feed whole milk as indicated above for the first 2 weeks, change from whole milk to skim milk during the third week. Increase the quantity of skim milk fed by 2 pounds daily each week until the calf is getting 12 pounds daily. Reduce the quantity of skim milk fed by 3 pounds per day each week during the fifth, sixth, and seventh weeks respectively for Holstein and Brown Swiss Calves, and during the seventh, eighth, and ninth weeks for Ayrshire, Jersey, and Guernsey calves, substituting warm water in the same way as above.

Calves raised on nurse cows:

Regulate the number of calves on a nurse cow so that each calf is getting from 6 to 8 pounds of milk daily. Allow the calves to suckle twice daily for the first 4 to 6 weeks, then once daily for 3 weeks, until weaned.

Feed each calf milk according to its size and condition, as long as warranted. Provide a convenient, abundant supply of pure water so that the calf will be accustomed to obtaining its own water before the quantity of milk fed is reduced.

When the calf is 10 days old, offer it both hay and grain. Feed the best-quality hay on hand, preferably a legume. Early-cut grass or mixed grass and legume hay are also suitable. Give the calf all the hay it will eat at all times. Feed the calf all of the grain or calf meal it will eat up to 4 or 5 pounds daily. When the calf is 3 months old, the calf meal can be gradually discontinued and a cheaper grain mixture fed so that at 4 months of age the calf is getting all grain. Feed 4 to 5 pounds of grain daily until the calf is 6 months old.

When the calf is weaned from milk at 50 to 60 days, it should be eating 1½ to 2 pounds of grain or calf meal daily, 3 to 4 pounds daily at 3 months, and 4 to 5 pounds daily at 4 months. The total quantity of grain or calf meal and grain required to 6 months of age on this basis will be about 400 pounds per head for Jerseys and 500 pounds for Holsteins. Where a calf meal is fed it will constitute approximately one-half of the grain.

The amount of hay consumed will depend on its palatability and also on the quantity of calf meal and grain fed. With hay of good quality and the above-mentioned quantities of calf meal and grain the calf can be expected to consume nearly as much hay as grain from weaning time to 4 months of age, and more hay than grain between 4 and 6 months of age; the total hay consumed by Jerseys

being between 400 and 450 pounds, and by Holsteins 500 to 600 pounds. With very palatable hay, heifers may consume somewhat more hay than this.

SILAGE

Silage is not a suitable feed for the young calf. The addition of this feed to the ration is apt to cause digestive disturbances and scours. Furthermore, it is desirable that the calf eat as much hay as possible during the first 3 months. However, silage makes a desirable feed to supplement hay after the calf is 3 months old. Corn, kafir, or sorghum silage, or silage made from pasture or hay crops may be fed.

Silage made from corn, kafir, sorghum, and from grasses which are nearing maturity, are low in protein. Silage made from legumes and from grasses cut while still immature are high in protein. Corn silage contains essential amino acids which may be lacking in some hay crops and is a particularly desirable feed for supplementing alfalfa and other legume hays. If forage crops are put in the silo while green and not more than slightly wilted, the silage will be a good source of vitamin A to supplement poor hay. However, silage is low in vitamin D.

When the calf is 3 months old it can be fed 1 or 2 pounds of silage per day. By the time it is 4 or 5 months old, it can be fed 1 pound of silage per day for each month of its age, or it can be fed 2 pounds of silage per day for each 100 pounds of live weight. Care should be taken not to feed any moldy or frozen silage, and any uneaten silage should be removed from the manger each day.

PASTURE

Pasturage is one of the best of feeds for the growing calf. However, the young calf will consume very little pasturage in addition to milk, hay, and grain, and young calves will do better in hot weather when kept in cool, well-ventilated quarters during the day than when allowed to run in a pasture or open lot in the sun. When the calf is 3 months old it will be able to make better use of pasturage, provided the grass is abundant and the weather is not too hot.

The pasturage provided for calves and heifers should be the best available and preferably consist of immature, rapidly growing grasses and clovers. Such pasturage is low in crude fiber and high in easily assimilable protein, carbohydrates, minerals, and vitamins and supplies a well-balanced feed for body maintenance and bone and muscle building.

Fall and early-winter calves are old enough to make good growth on pasture the following spring and summer when the pasture is properly supplemented. Spring calves will not be old enough to make much use of pasture until late in the summer and during the fall when pastures are often poor. For this reason, it is best to keep spring and summer calves off pasture, except for exercise, until the following summer.

Calves on good pasture should have both milk and grain until they are 6 months old.

MINERALS

Salt should be provided as soon as the calf is old enough to eat hay and grain. One pound of salt may be added to each 100 pounds of the grain mixture or the calf meal. Salt should also be placed in a conveniently located box where the calf can have access to it as desired.

The ration of the calf receiving a well-cured legume hay, grass hay, or mixed legume and grass hay, and a suitable grain mixture, along with salt, will usually be adequate in minerals. Experiments at a number of agricultural experiment stations have shown that under these conditions no benefit is derived from the addition of supplemental minerals to the growing animal's ration.

However, in localities where there is a shortage of phosphorus in the soil, rations consisting of home-grown feeds may be deficient in this mineral. Wheat bran and linseed meal are high in phosphorus, and the inclusion of one of these feeds in the grain mixture will take care of any phosphorus deficiency. Bonemeal is rich in phosphorus and calcium and is a suitable supplement for use where phosphorus is deficient in the ration. A special high grade of feeding bonemeal or poultry bonemeal which has been heated sufficiently to kill disease bacteria is suitable for this purpose. The bonemeal can be added to the grain mixture at the rate of 1 pound to each 100 pounds of grain, or it can be mixed with salt at the rate of 3 or 4 parts of bonemeal to 1 part of salt and placed in a box alongside the salt box where the calves and heifers can have access to it as desired.

In regions where calves are born with big neck or goiter, iodine may be deficient in the ration. However, the supplemental use of iodine in the ration is necessary only in feeding pregnant cows and heifers, so that the calf will be normal at birth. Iodine may be given effectively by mixing with the feed of the pregnant cow once each week a tablespoonful of a 5-percent solution of potassium or sodium iodide.

VITAMINS

Vitamins are certain substances other than protein, carbohydrates, fats, and minerals that occur in minute quantities in natural food substances and are essential to the life and health of animals. Those vitamins studied have been named A, B, C, D, E, G, K, and P. Vitamin B is sometimes called B₁ or F, and vitamin G is sometimes called B₂. Both these vitamins were formerly called B.

Of these eight vitamins, A is the one most likely to be deficient in the calf's ration, according to the information so far obtained. Vitamin A has to do with the growth, health, and to a certain extent, perhaps, to resistance to infections, though it does not confer immunity. Carotene, one of the yellow pigments of plants from which vitamin A is formed in the animal body, occurs in close association with the green coloring matter of pasture plants and other green forage, and also with the green coloring matter of cured roughages. In carrots and yellow corn it occurs in dissociation from the green color. The vitamin A content of yellow corn, however, is very low in comparison to that of carrots and green roughages. As a rule, the greener the color of the roughage the greater its content of carotene.

Vitamin D is not present to any appreciable extent in green growing plants. Naturally cured hay, dried in the sunlight, absorbs this vitamin from the ultraviolet rays of the sun. The calf can obtain part of its vitamin D requirements by exposure to direct sunlight.

Vitamin D or some unidentified property of pasture grass, or of other green forage, or of hay cured with much of its natural green color, is useful in promoting the assimilation of calcium or lime, and the retention of calcium in the body.

Feeding experiments with dairy cattle at Beltsville show that cows fed for extended periods on a ration deficient in vitamin A give birth to weak, dead, or immature calves; that the vitamin A content of milk produced by cows on such rations is also greatly reduced; and that calves fed the milk from cows that have received a vitamin A deficient ration for some time will cease to grow and will soon die if fed a poor grade of hay low in vitamin A, but if given supplementary feeds rich in vitamin A or carotene they will survive. Whether this is due entirely to a deficiency of vitamin A has not been determined definitely.

In these experiments it was found possible to prevent this condition, or bring the calf back to normal health and rate of gain in body weight by the addition of 20 cubic centimeters of cod-liver oil daily to the ration.

When the dairy calf's ration is deficient in vitamin D, sufficient calcium or lime may not be deposited in the bones, and a rachitic condition known as rickets may develop, especially during the winter months. Experimental work has also shown cod-liver oil to be effective in preventing or curing this condition.

In the light of present knowledge it appears that when a normal, healthy calf is fed a ration adequate in quantity and in the vitamins A and D, no benefit will be derived from cod-liver oil. Since winter milk does not ordinarily contain as much of vitamins A and D as summer milk and because the young calf consumes hay in very limited quantities, it may be desirable to give cod-liver oil to calves up to 2 or 3 months of age during the winter feeding period, if the calf does not seem to be thrifty or gaining as well as it should.

In feeding the calf, provide as much of vitamins A and D in the ration as possible by feeding it milk in summer from cows receiving pasture or green-cut feed and in winter early-cut hay cured so as to retain its natural green color and most of its leaves. Beginning at an early age, feed the calf all the hay of this quality it will eat in addition to the milk.

FEEDING HEIFERS FROM 6 MONTHS TO 2 YEARS OF AGE

By the time the heifer is 6 months old the feeding of skim milk or special calf meals has been discontinued. At this age, it is still growing rapidly but can make good growth largely on roughage feeds of good quality, supplemented by a little grain. By the time the heifer is 1 year old, it is usually past the period of maximum gains, can consume more roughage, and can make normal growth with still less grain. Plenty of good roughage should be supplied at all times

in the form of good pasture in summer, and hay or hay and silage in winter. Fodder can be used to provide part of the roughage for heifers over 1 year of age.

SUMMER FEEDING

During the grazing season the heifer should be provided with good pasturage when available (fig. 7). Second growth from hayfields or crops such as rye and vetch, oats and peas, Sudan grass, soybeans, Italian ryegrass, and sweetclover may be used as temporary pasture to supplement short permanent pasturage. When temporary pastures are not available, heifers can be fed hay or hay and silage while on early spring pasture or short summer pasture. It is desirable to keep



FIGURE 7.—Pastures should furnish shade and water as well as good grazing.

a supply of good hay available at all times throughout the grazing season in a conveniently located rack so that the heifer can eat hay at will.

When pastures are at their best (grass immature and abundant) or when short pastures are supplemented by unlimited good-quality hay or hay and silage, heifers 6 to 9 months of age will not require more than 3 pounds of grain a day, and heifers over 9 months old will not need any grain. On the other hand, if a limited quantity of good roughage is fed with poor pasture, or the roughage fed with such pasture is poor in quality and unpalatable, 6- to 9-month-old heifers may require as much as 5 pounds of grain and older heifers 3 to 5 pounds in order to maintain growth at a normal rate (fig. 8).



FIGURE 8.—Heifers on pasture need supplementary feed.

WINTER FEEDING

During the winter season, the heifer should be so fed that she will make about normal growth but will not get fat. Heifers that are in a high state of flesh when they go on pasture will make smaller-than-normal summer gains. The growing heifer should have all the hay she will eat at all times. The hay may be either legume, mixed grass and legume, or grass hay. It should preferably be early-cut, fine-stemmed, and leafy and grade not less than U. S. No. 2 for green color. After the heifer is 1 year of age part of the roughage may be corn, kafir, or sorghum fodder if it has a bright color. If silage is available, it may be fed to replace part of the dry roughage. Corn, kafir, or sorghum silage makes a good feed to supplement legume, mixed, or grass hays. Grass or legume silage makes a good feed to supplement mixed or grass hays, or corn, kafir, or sorghum fodder. If the hay or fodder has a green color and is readily consumed in large quantities, 2 pounds of silage per day per 100 pounds of live weight is enough to feed the growing heifer. If the hay or fodder is of only ordinary or poor quality the quantity of dry roughage fed can be reduced to 4 or 5 pounds or less per head daily and the heifer fed all the silage in addition that it will consume.

When fed all the roughage she will eat, the 6- to 9-months-old heifer will need about 3 pounds of grain per day with roughage of good quality, or 5 pounds with roughage of only ordinary quality. Heifers more than 9 months old will not require any grain with a roughage ration of good hay or good hay and silage, but may need 2 to 3 pounds daily along with silage and ordinary hay; or 5 pounds with ordinary hay or with such hay and corn, kafir, or sorghum fodder. In some irrigated sections of the West, heifers are raised on good alfalfa hay and skim milk without grain or with only a small amount of grain.

When heifers have been allowed free access to a good quality of alfalfa hay so that they could eat all they want at all times without consuming the coarse stems, they have made normal or near normal growth from birth on skim milk and alfalfa hay without any grain or with only very limited quantities of grain. The Nevada station in an experiment with this method, obtained an average weight at 12 months of age of 650 pounds for Holstein heifers with only one-half pound of grain daily from birth to 6 months of age. These heifers were kept in a separate lot and were fed alfalfa hay from an outside rack. All hay was weighed. The hay consumption amounted to 13 pounds per head daily at 6 months of age, 19.5 pounds at 9 months, and 26 pounds daily at 12 months of age.

The ration will contain plenty of protein if grain containing 10 to 12 percent of protein is fed along with immature, abundant pasture or leafy legume hay or early cut mixed or grass hay or with such hays and grass or legume silage; grain containing 14 to 16 percent of protein with ordinary and less abundant pasturage, with good hays and corn, kafir or sorghum silage or fodder; or with poor hay made from mature grass or from legumes that were very mature and have undergone considerable shattering; or with such hay and grass or legume silage; and grain containing 18 to 20 percent of protein with poor hay alone, or with such hay, corn, kafir, or sorghum silage or fodder. Suitable grains and grain mixtures for feeding heifers of this age are listed on page 16.

EFFECT OF DIFFERENT METHODS OF FEEDING ON THE GROWTH OF DAIRY HEIFERS

The effects of different methods of feeding on the growth of dairy heifers is shown in table 3, which gives the average live weights by months from birth to 2 years of age for Holstein heifers raised at the Federal dairy experiment stations at Huntley, Mont., and Ardmore, S. Dak., and for both Holstein and Jersey heifers raised at Beltsville, Md.

At Huntley, the heifers were fed whole milk for about 1 month and then skim milk, together with grain and alfalfa hay, until they were 9 months old. After the age of 9 months, they received alfalfa hay and corn silage without grain. They were also on irrigated pasture about 2 months during the second year.

At Ardmore the heifers were fed whole milk about 1 month, and then skim milk, together with grain, alfalfa hay, and corn silage, until they were 6 months old. After they were 6 months of age they received hay, corn silage, and grain in winter and were on native unirrigated pasture in summer without any other feed, during both the first and second years. The hay fed was about two-thirds alfalfa and one-third barley, millet, brome grass, and sweetclover hays combined. The grain consisted entirely of a mixture of home-grown grains. The quantity of grain fed did not exceed 2 pounds per head per day, except that some of the heifers received extra grain during one winter when there was a shortage of roughage feeds.

At Beltsville, the method of feeding used for both Holstein and Jersey heifers was as follows: They received whole milk until they were about 1 month of age and then had skim milk in moderate quantities, together with grain, alfalfa hay, and corn silage until they were 6 months old. After the sixth month they received grain, hay, and corn silage. During the summer of the second year most of the heifers were on pasture and also had grain except for a short time when the pasture was at its best. The rate of grain feeding was increased to a maximum of about 4 pounds per day for Holstein heifers and 3 pounds per day for Jersey heifers.

The rate of growth and general appearance of a Holstein heifer and a Jersey heifer from 1 month to 2 years of age and at maturity, raised by this method of feeding in the experimental breeding herd at Beltsville, are shown in figures 9 and 10. The Jersey heifer is larger than the average of the Beltsville Jersey heifers as shown in table 3.

TABLE 3.—Average body weights by months from birth to 2 years of age for Holstein heifers at the Huntley (Mont.), Ardmore (S. Dak.), and Beltsville (Md.), experiment stations, and for Jersey heifers at the Beltsville station

Age	Holstein			Jersey	Age	Holstein			Jersey
	Huntley ¹	Ardmore ²	Beltsville ³	Beltsville ⁴		Huntley	Ardmore	Beltsville	Beltsville
	Pounds	Pounds	Pounds	Pounds		Pounds	Pounds	Pounds	Pounds
At birth...	87	90	97	51	13 months..	750	628	662	490
1 month....	126	132	121	72	14 months..	786	659	708	515
2 months....	174	184	155	92	15 months..	807	689	745	538
3 months....	231	238	197	128	16 months..	842	707	777	562
4 months....	294	294	253	168	17 months..	870	730	812	583
5 months....	361	342	303	211	18 months..	905	752	840	603
6 months....	425	403	360	257	19 months..	936	787	881	627
7 months....	488	449	407	299	20 months..	969	824	912	644
8 months....	544	485	460	335	21 months..	990	860	944	666
9 months....	594	515	507	372	22 months..	1,016	894	982	693
10 months...	634	537	553	404	23 months..	1,050	934	1,016	722
11 months...	680	560	586	436	24 months..	1,071	973	1,057	743
12 months...	721	590	627	466					

¹ Average of 16 heifers.

² Average of 17 heifers.

³ Average of 27 heifers.

⁴ Average of 35 heifers.

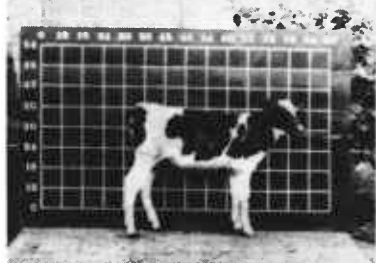
Of the three groups of Holstein heifers, two showed very little difference in the average body weight at 2 years of age, while the third averaged somewhat less in weight. The Holstein heifers at Ardmore weighed on an average 43 pounds more at 6 months, 37 pounds less at 1 year, 88 pounds less at 18 months, and 83 pounds less at 2 years of age than the Holsteins at Beltsville. The Holstein heifers at Huntley, as compared with those at Beltsville, weighed 65 pounds more at 6 months, 88 pounds more at 9 months, 94 pounds more at 12 months, 61 pounds more at 18 months, and 14 pounds more at 2 years of age. The alfalfa hay fed to the heifers at Huntley was probably of higher average quality than the hay fed to the heifers at Ardmore and Beltsville.



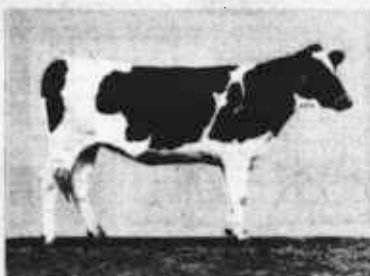
Age 1 Month
Weight 125 Pounds



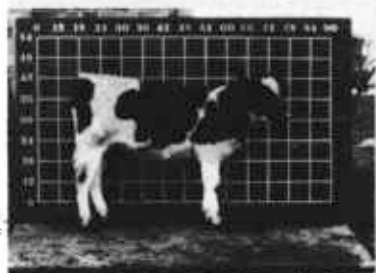
Age 1 Year
Weight 654 Pounds



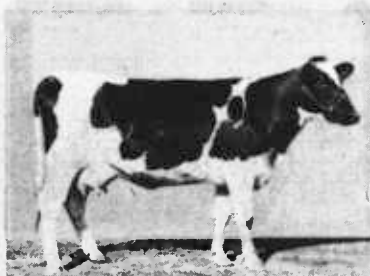
Age 3 Months
Weight 210 Pounds



Age 1 Year 7 Months
Weight 874 Pounds



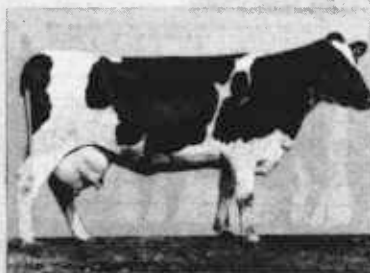
Age 6 Months
Weight 360 Pounds



Age 2 Years 4 Months
Weight 1,100 Pounds



Age 9 Months
Weight 499 Pounds

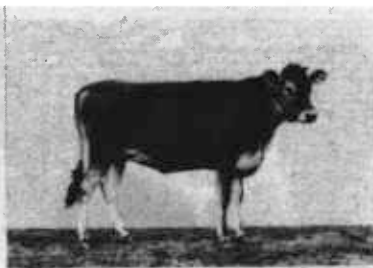


Age 5 Years 7 Months
Weight 1,470 Pounds

FIGURE 9.—Pictorial record of the growth of a Holstein female at the ages stated, in the experimental breeding herd of the Bureau of Dairy Industry at Beltsville, Md. (Mature-age record, 21,516.1 pounds of milk and 727.4 pounds of butter-fat.)



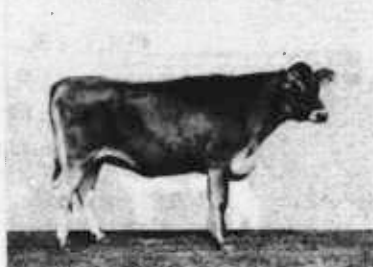
Age 1 Month
Weight 77 Pounds



Age 1 Year
Weight 531 Pounds



Age 3 Months
Weight 155 Pounds



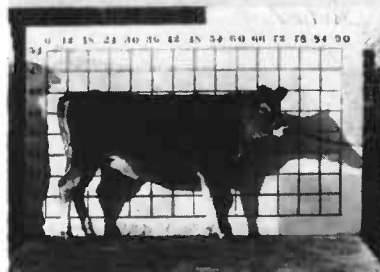
Age 1 Year 6 Months
Weight 717 Pounds



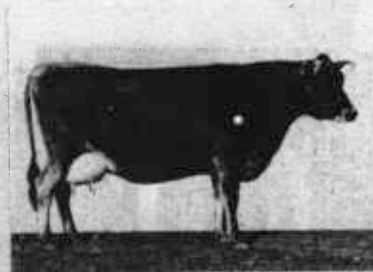
Age 6 Months
Weight 305 Pounds



Age 2 Years 1 Month
Weight 914 Pounds



Age 9 Months
Weight 394 Pounds



Age 5 Years 10 Months
Weight 1,215 Pounds

FIGURE 10.—Pictorial record of growth of a Jersey female at the ages stated, in the experimental breeding herd of the Bureau of Dairy Industry at Beltsville, Md. (Mature-age record, 12,903.0 pounds of milk and 763.99 pounds of butterfat.)

QUANTITIES OF FEED CONSUMED BY DAIRY HEIFERS FROM BIRTH TO 2 YEARS OF AGE

In an experiment at Beltsville to determine the feed requirements of growing dairy heifers, 5 Holstein and 5 Jersey heifers were fed from birth to 2 years of age similarly to the other heifers at Beltsville, except that they received no pasture. These 10 heifers were so fed that they would gain rapidly but would not be excessively fat. They were raised without pasture because an accurate record could then be made of all the feed that they consumed. Their average body weights at 2 years of age were about the same as the averages for the other Holstein and Jersey heifers at Beltsville given in table 3. The monthly body weights, different ages, and total feed consumption to 2 years of age are shown in table 4.

TABLE 4.—*Feed consumed and gains made by Holstein and Jersey heifers from birth to 2 years of age*¹

[Average of 5 heifers each]

Year and 30-day period	Holstein						Jersey					
	Whole milk	Skim milk	Grain	Alfalfa hay	Corn silage	Weight at end of month or period	Whole milk	Skim milk	Grain	Alfalfa hay	Corn silage	Weight at end of month or period
	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.
First year:												
At birth.....	223.0	20.8	1.7	1.9	1.5	103	121	197.6	44.6	0.5	0.8	0.4
1.....	16.7	324.5	20.5	19.3	23.8	151	1.5	286.0	7.6	10.3	8.6	73
2.....	0.0	402.2	53.9	36.0	71.6	197	0.0	344.7	28.4	24.6	32.6	127
3.....		402.2	76.2	55.8	118.4	251		343.8	56.9	39.0	75.0	166
4.....		402.2	87.4	70.1	180.6	308		344.7	75.9	61.1	116.6	211
5.....		399.5	87.9	70.4	234.5	363		344.7	86.5	75.2	169.4	256
6.....		0.0	89.1	79.7	334.0	408		1.1	89.1	80.3	271.3	300
7.....			89.1	87.0	418.5	450		0.0	88.9	84.1	353.6	336
8.....			89.1	89.6	455.9	496			89.1	87.3	390.3	375
9.....			93.9	89.6	517.2	545			89.1	87.4	427.4	406
10.....			94.8	97.0	576.8	582			89.1	88.7	460.4	436
11.....			92.7	110.6	615.0	624			89.0	88.0	483.6	468
12.....			15.5	18.5	105.5	---			14.9	14.6	83.3	---
Last 5 days only.....												
Total.....	239.7	1,951.4	891.8	825.5	3,653.3	624	199.1	1,709.6	805.0	741.4	2,872.5	468
Second year:												
13.....			120.0	136.8	516.2	656			88.3	97.4	298.3	490
14.....			111.9	135.1	565.1	695			89.1	112.4	301.9	516
15.....			106.9	136.6	606.5	735			89.1	115.2	330.6	538
16.....			106.9	142.8	601.4	771			89.1	119.2	364.7	562
17.....			106.2	149.6	621.6	797			88.9	116.0	423.6	586
18.....			106.9	148.8	673.9	829			89.1	119.0	457.4	606
19.....			106.9	148.6	697.2	866			89.1	118.6	502.0	625
20.....			101.0	144.0	680.9	898			89.1	118.2	520.4	645
21.....			95.0	148.8	717.6	933			89.1	118.2	534.2	672
22.....			95.0	148.2	759.0	977			89.1	118.6	540.8	699
23.....			95.0	136.6	745.0	1,019			89.1	119.6	565.0	728
24.....			93.5	143.2	735.4	1,069			88.9	119.0	553.4	752
Last 5 days only.....			14.9	24.8	123.0	---			14.9	20.0	87.0	---
Total.....			1,260.1	1,743.9	8,042.8	1,069			1,082.9	1,411.4	5,479.3	752
Total.....	239.7	1,951.4	2,151.9	2,569.4	11,696.1	1,069	199.1	1,709.6	1,887.9	2,152.8	8,351.8	752

¹ From unpublished reports of experiments by H. T. Converse on the feed requirements for growth in dairy cattle.

When available, good pasture can be used to replace all the roughage for heifers over 6 months of age and to replace both roughage and grain for heifers over 9 months of age. When pastures begin to get short, heifers will require grain and later on some roughage also, to keep them gaining as rapidly as the heifers in this experiment.

QUARTERS

When the heifer is not on pasture she requires dry, well-bedded, well-ventilated quarters, and a suitable place to exercise. These can be provided by a pen in a barn, or an outside shed open to the south, with access to a yard that is large enough to allow her to take plenty of exercise. Feed mangers and boxes should be kept clean and sanitary. As far as practicable, heifers of about the same age should be kept together and separate from those older or younger. On farms where large numbers of young stock are raised, the calves and heifers are often housed in a barn built especially for that purpose.

AGE FOR BREEDING

The age to breed depends on the growth and development of the heifer. Since she will not yield any income until she has freshened, she should be fed liberally in order that she may be bred to freshen at 2 years of age or soon thereafter. As the calf is carried about 280 days, the well-grown heifer should be bred when 15 to 18 months old. At Beltsville good results have been obtained by having well-grown Jersey and Holstein heifers freshen soon after 2 years of age. If the heifer is not undersized, nothing is gained by breeding for freshening at a later date. However, the breeding of heifers that have not made good growth should be delayed somewhat, since too early calving under such conditions may result in smaller-than-average cows at maturity.

FEEDING THE HEIFER BEFORE AND AFTER CALVING

The heifer should be growthy and in good flesh at calving time; otherwise she may not give as much milk as she should after calving, or grow at a satisfactory rate during her first milking period. On the other hand, she should not be excessively fat, as this will not make her a better milk cow and may result in calving difficulties and congestion of the udder.

If 3 or 4 months prior to calving the heifer is growing at about a normal rate and is well-fleshed, the ration being fed can be continued to near calving time without increasing the quantity of grain. If the heifer is in only fair flesh, 4 or 5 pounds of grain per day will be sufficient with liberal quantities of good roughage. If the heifer is somewhat thin or the roughage is not of the best quality, it may be necessary to feed her 6 to 8 pounds of grain per day in order to have her in good flesh by calving time. The grain mixture fed should contain enough protein to balance the roughage fed. (See p. 16.) Several weeks before calving, it is desirable to include in the grain mixture ground oats, wheat bran, and linseed meal. As calving time approaches, the heifer should have only moderate quantities of hay and silage, and the drinking water should not be too cold.

After calving, the heifer should be fed sparingly for a few days in order to help prevent digestive disorders and to help in reducing the swelling in the udder. She should have warm water to drink after calving, and a little good hay as soon as she cares to eat it. The second day she can be fed hay, a little silage, and 4 pounds of grain. Roughage can then be fed liberally, and the grain increased gradually, until she is on full feed at 3 to 4 weeks after calving. From this time on throughout the first lactation period, the ration fed should contain sufficient amounts of total digestible nutrients and protein for maintenance and milk production, as calculated by a common feeding standard. This is discussed elsewhere in this bulletin, and in Farmers' Bulletin 1626, Feeding Dairy Cows. In addition, enough nutrients above these requirements should be provided to enable continuation of normal growth during the first lactation period.

Heifers that are undersized at first calving because of underfeeding or calving at too early an age may, if properly fed during the first lactation, gain as much as 125 to 150 pounds between first and second calving, exclusive of the increased weight of gestation or differences in weight due to differences in degree of fleshing at calving time. On the other hand, heifers which are large at first calving, because of liberal feeding or delayed first calving, may not gain more than 50 to 75 pounds in weight during this period.

As a rule it will be well to provide additional nutrients for at least 100 pounds of gain in live weight and, if the heifer is considerably undersized at first calving, for as much as 150 pounds of gain during the first lactation period. It is probable that at this age as much as 3 pounds of digestible nutrients will be required to produce 1 pound of gain in live weight in the animal, or from 300 to 450 pounds of total digestible nutrients. These quantities of nutrients will be provided by 400 to 600 pounds of grain or 600 to 900 pounds of hay.

HANDLING THE HEIFER

Kindness in the care of the heifer will make her easier to handle when she enters the milking herd. Teach her to lead at an early age. Stall or house her with the milking herd a month or so before she is due to freshen. If possible, give her the stall she is to occupy after calving. Handle her daily during this period in a quiet, gentle manner that will gain her confidence. After she freshens, milk her carefully and quietly so that she will not get excited. The development of a nervous condition at this time may cause the heifer to form the habit of kicking or holding up her milk.

FEEDING AND MANAGEMENT OF THE YOUNG BULL

The bull calf is slightly larger at birth than the heifer calf and has a considerably larger inherited mature size. The young bull calf should have about the same kind of feed and care as the young heifer calf. The bull and heifer calves can be raised together at first, but at about 4 months of age bull calves should be kept in separate pens and lots. Because of the bull calf's more rapid growth rate and larger size he will require more feed than the heifer after the sixth month of age.

The bull calf should have liberal quantities of good legume or mixed grass and legume hay and all the grain he will eat up to 4 to 6 pounds per day to 6 months of age. With good hay liberally fed, the amount of grain required to keep a bull growing satisfactorily from 6 months to 2 years of age will rarely exceed 4 to 5 pounds a day. If limited quantities of hay are fed or the hay is low in quality, more grain may be required. The grain mixture should contain sufficient protein to properly supplement the roughage fed. Suitable grain mixtures are listed on page 16. Oats and linseed meal are particularly desirable ingredients to include in grain mixtures for dairy bulls. Silage is a bulky feed and has a tendency to distend the paunch, but it may be fed beginning when the bull is 3 or 4 months of age if it is limited to quantities not exceeding 1 pound per day for each month of age, or a total of not over 8 or 10 pounds daily for bulls 1 year old and 10 to 15 pounds daily for bulls 1 to 2 years of age or over. Moderate quantities of other succulents such as roots, or green forage crops in season may also be fed. A good-sized lot or small pasture which provides some green grass and considerable chance for exercise is also desirable for growing bulls.

If growthy and well developed, the dairy bull will be old enough for light service when 12 months old. His feeding from this time on should be such that he will be neither too fat nor too thin but able to make about normal growth. The roughage fed should be limited to quantities that will not develop too large a paunch, so that the bull will remain active and vigorous. More detailed information on the feeding and handling of dairy bulls will be found in Farmers' Bulletin 1412, *Care and Management of Dairy Bulls*.

FEEDING DAIRY CALVES FOR VEAL

Dairy calves not raised for breeding purposes are sometimes marketed as veal. Calves fed for veal are usually marketed between 3 weeks and 3 months of age, the majority being sold between 4 and 8 weeks of age. Detailed information on classes of veal calves is given in Department of Agriculture Circular 28, *Market Classes and Grades of Calves and Vealers*. Vealers weighing 110 pounds or less are classified as lightweight, those weighing from 110 to 180 pounds as mediumweight, and those weighing over 180 pounds as heavyweight. Each weight division is further classified into several grades on the basis of conformation, finish, or degree and smoothness of fleshing and fat, and quality of the meat. When properly finished, the calf that is blocky and compact in conformation will dress out a larger percentage of the high-priced cuts than the calf that is angular and rangy. Consequently it commands a higher market price. Vealers of mediumweight usually bring a higher price than either lightweight or heavyweight vealers.

Whole-milk feeding produces the best grade of veal. Where the calf receives grain and hay in addition, these should be fed in very limited amounts. Approximately 10 pounds of whole milk is required to produce 1 pound of gain in live weight. In feeding calves for veal, during the first week give about 7 pounds of whole milk per day to the 60- to 70-pound calf, 8 pounds to the 70- to 80-pound calf, 9 pounds to the 80- to 90-pound calf, and 10 pounds to the 90- to 100-pound calf. After the calf is a week old, increase the quantity of whole milk

gradually until a good-sized, vigorous calf is receiving from 16 to 20 pounds or more per day before it is marketed. Calves will fatten more rapidly if fed three times daily and confined so that they get little exercise.

Unless veal is high in price as compared with milk, the value of 10 pounds of whole milk will usually exceed the value of 1 pound of gain that it produces. Any profit to be made will come, therefore, not from the gain in weight but from the value of the initial or birth weight of the calf. For this reason, profits can only be expected from the feeding for veal of the calf that is large at birth and blocky and compact in conformation. The calf should be fed until it attains a high state of flesh, as thin or inferior calves will not bring a good price. On the other hand, the calf should be marketed as soon as it reaches the proper condition, since the continued feeding of whole milk will not increase the selling price per pound and will lessen the profit to be made from it.

PREVENTING HORNS

The development of horns can be easily prevented by the use of caustic soda or caustic potash. This material is usually used in the stick form, which is procurable in most drugstores or from dairy-supply houses. Caustic paste is also suitable for this purpose and is a little easier to apply than stick caustic.

The best time to apply caustic is when the calf is from 4 to 10 days old. At this age the undeveloped horn or button is not attached to the skull and appears more as part of the skin. Growing horns can also be successfully treated with caustic up to the age of 2 or 3 months. The horns of older calves require more caustic and are more bother to treat.

Before applying the caustic, clip off the hair from around the horn buttons, and apply petrolatum to the surrounding area to prevent the caustic accidentally coming in contact with it and causing severe burns.

To apply stick caustic, wrap the stick in paper with one end exposed, or slip it part way into a small rubber tube. Slightly moisten the exposed end with water and rub each horn button alternately, making a raw spot about the size of a nickel. Do not continue rubbing until these spots bleed; merely take the outer skin off of the horn buttons. In treating growing horns, do not treat the tip but make a raw ring completely around the base of the horn where it joins the skin, by rubbing with the stick of caustic. The horn grows from the skin at its base, and destroying this tissue will stop the development of the horn. Do not cut off the horn with a knife, as this causes bleeding which will wash off the caustic. In applying the caustic, use only a minimum of water so that the caustic will not run down the calf's head. The method of applying stick caustic to prevent the growth of horns is illustrated in figure 11.

When using caustic paste, clip only the hair immediately over the horns as the surrounding hair will help to hold the paste in place. Spread a quantity about the size and thickness of a nickel on each horn button. In treating growing horns make a raw ring around the base of the horn where it joins the skin by rubbing with sandpaper or an ordinary file, but do not draw blood. Then apply the caustic paste to this ring, using a little more than for younger calves. Caustic

paste is irritating in action, and the calf will attempt to rub it off, or scratch it off with a hind foot. To prevent this, confine the calf in a close-fitting stanchion during the operation and for a half hour afterwards. If the stanchion does not fit the neck closely the calf is likely

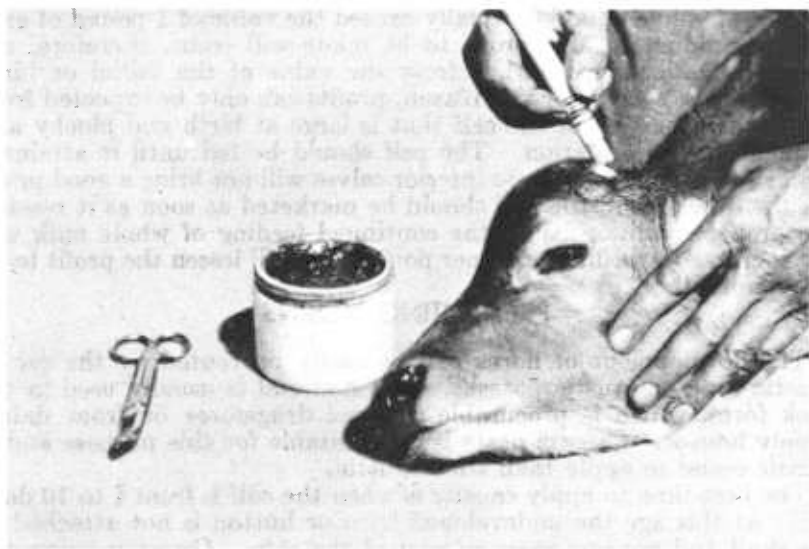


FIGURE 11.—Applying stick caustic to prevent the growth of horns.

to pull back until its ears touch the caustic applied to the buttons, thus causing severe burns.

After treating the horns with caustic, protect the calf from rain for a day or so.

Caustic absorbs moisture from the air and deteriorates rapidly when kept in an open container. When not in use, it should be kept in a small glass jar or bottle tightly closed by a rubber stopper.

MARKING CALVES FOR IDENTIFICATION

It is important, especially in registered herds, that each calf be marked plainly for easy identification. This is best accomplished by using metallic or composition eartags or by tattooing the ears. Breeding and calving records, photographs, and diagrams of color markings are also helpful.

Fiber-disk eartags used for identification are fastened to the thick upper part of the ear by means of a hog ring that pierces the ear (fig. 12).

Tattooing the ear is a simple operation (fig. 13) and insures a permanent method of identification when properly done. It is accomplished by (1) thoroughly washing the dirt and wax out of the inside of the ear with either alcohol or gasoline, and then drying the ear; (2) a series of letters and numbers composed of needle points mounted on blocks are placed in a tattoo marker, the needle points are covered with tattoo ink and pressed deep into the central part of the inside of the ear that is free from hair; (3) the tattoo ink or oil is then thoroughly

rubbed into these perforations with the finger tips. Black tattoo ink is used for ears with light-colored skin, but is not satisfactory for ears with dark-colored skin. Red ink is sometimes used for ears with dark-colored skin, but is hard to read and not very satisfactory.



FIGURE 12.—Fiber-composition eartag with number for identification.



FIGURE 13.—Number tattooed in heifer's ear for identification.

REMOVING SUPERNUMERARY TEATS

Often the udder of dairy heifers has extra or supernumerary teats, in addition to the four normal teats. Although such teats do the heifer no harm, they may be unsightly when she matures and may make milking more difficult. In some cases an extra teat may secrete milk, and in that event may cause considerable bother by leaking at milking time.

Extra teats can be easily removed up to 1 year of age. Stretch out the teats and cut off close to the udder with a sharp pair of scissors. Apply iodine or some other good disinfectant both before and after the operation. In some cases in older animals it may be necessary to dissect out the teat and its accompanying gland. This should be done only by a person skilled in veterinary surgery.

PURGATIVES AND ENEMAS

Olive oil makes the best purgative for very young calves but is more expensive than other purgatives. Mix 4 to 6 ounces of olive oil with 1 pint of warm milk. Give this to the calf from a long, narrow-necked bottle either with or without a nipple. Take care to hold the bottle so that the liquid runs out slowly, or some of it may get into the lungs. Mineral oil may be used in place of olive oil.

Castor oil is a good purgative but has a stronger action than olive oil and may be too irritating for very young calves. The usual dose is 1 to 3 ounces, given in the same manner as olive oil.

Epsom salts makes a suitable purgative after the sixth month of age. One-fourth of a pound will be enough for a 6-month-old calf, and one-half pound or more may be used for older animals, depending on their size. Mix with a pint or more of warm water and give from a long, narrow-necked bottle.

A physiological salt solution makes the best enema for calves. Do not use any other material as an enema except on the advice of a veterinarian. To make this solution, heat water to a temperature of 110° F. and add 1 heaping teaspoonful of common table salt to each quart of water to be used. Two quarts of this solution will be sufficient for most calves. Administer the solution by gravity through the rectum of the calf, using either a tube and funnel or an ordinary fountain syringe.

COMMON AILMENTS OF CALVES³

Calves are susceptible to various ailments. They consist principally of digestive disturbances, lung troubles, and parasites. Most of these ailments can be prevented by keeping the calf in clean, well-ventilated surroundings and by proper feeding and care. Space should be provided or construction so arranged as to permit segregation of any visibly sick animals.

WHITE SCOURS

White scours is a specific and highly contagious disease of calves which shows itself at birth or shortly after birth. The infection usually takes place through the naval cord but may occur through the digestive system. Soiled bedding in the pen, soiled udder and teats, or sick calves in nearby pens with open partitions are possible sources of infection.

A calf affected by this disease wants to sleep all the time and cannot be induced to eat. There is a profuse discharge of yellowish-white droppings with a highly offensive odor. The disease is nearly always fatal, and the calf dies within 3 or 4 days.

³ This section revised by Paul C. Underwood, associate veterinarian, Bureau of Dairy Industry.

Preventive measures are the best cure for white scours. Have the cow calve in an isolated and thoroughly cleaned and disinfected maternity pen, care for the calf as outlined under the heading Care of the Newborn Calf, and keep it isolated until all danger of the disease is past.

In case of an outbreak of contagious scours destroy the carcasses of all dead calves; remove the infected bedding and other material from the pens and destroy or spread at once on cultivated fields; thoroughly disinfect the pens and all tools and equipment used around the pens. If these measures do not prove effective, consult a veterinarian.

CONSTIPATION

When the calf is born there exists in the posterior bowel a greenish-black mass, known as meconium. The meconium should be expelled within 12 hours. If it is not expelled, the bowel remains inactive. This condition lowers the calf's resistance to infections that may cause its death in a short time.

If the calf receives a normal quantity of the first milk, or colostrum, which is purgative in nature, the meconium is usually expelled within a short time. In the few instances where the meconium is retained, its removal can be effected and the bowels started to functioning normally by a physiological salt solution used as an enema.

Constipation of older calves from other causes can be corrected by the use of a suitable purgative.

SCOURS FROM INDIGESTION

Indigestion followed by scours may be caused by overfeeding, irregular feeding, use of unclean utensils, feeding cold milk, too rapid changes in feed, cold drafts, and cold, damp floors. It is caused in most cases by overfeeding, which distends the stomach, and which in turn retards or stops the flow of gastric juices. When this happens the feed is not properly digested, the calf is weakened, resistance is lowered, and infections may gain a foothold.

The products of decomposing feed are absorbed by the body, and the calf becomes listless and dull 24 hours before any other symptoms appear. The calf may also be constipated before the scouring starts. The droppings become pasty or liquid in consistency but are not usually as light in color or as offensive in odor as in the case of white scours. In severe cases the droppings may get lighter in color, more offensive in odor, and blood may sometimes be present.

If it is noted that the calf is listless, reduce the quantity of feed and give a suitable purgative. This will check the indigestion before scouring starts, and the calf will soon be back to normal.

Where the calf has started scouring, reduce its feed by one-half and give a suitable purgative. Repeat the dose in a day or two if necessary. An enema of physiological salt solution will also be helpful in clearing the infection out of the bowels.

In severe cases decrease the total quantity of milk fed for the day by one-half and divide into three small feeds.

In each feed place 1 teaspoonful of the following mixtures: Bismuth subnitrate 1 part, sodium bicarbonate 3 parts, and salol 1 part. Continue this treatment until the calf's condition improves.

Blood in the droppings is sometimes an indication of an infectious disease known as coccidiosis caused by a protozoan organism. Where such a condition persists, a veterinarian should make a diagnosis and give instructions for ridding the farm of the disease.

PNEUMONIA

Congestion of the lungs, followed by pneumonia, occurs in many calves that have had indigestion and scours, especially when not properly taken care of in the early stages. The prompt treatment of scours will therefore lessen the danger of pneumonia.

Calves also get congestion of the lungs and pneumonia when exposed to sudden changes of temperature, and especially in windy weather when doors or windows are accidentally left open or are blown open.

The cold draft passing over the calf takes heat from its small body, bringing on a chill.

A calf with pneumonia usually lacks an appetite, breathes rapidly, is constipated and runs a temperature as high as 105° or 106° F. Severe cases are usually fatal.

Blanket the sick calf and place it in a dry, well-bedded pen at a comfortable, even temperature and away from all drafts. Give it moderate quantities of feed. Use a purgative if necessary to avoid constipation. Massage or rub the calf all over vigorously several times a day. If the animal is valuable, consult a veterinarian for further treatment.

LUNG PARASITES

In some localities the lungs of calves become infested with parasites. When this occurs, it is best to have a veterinarian prescribe the proper treatment and sanitary measures best suited to the premises. Isolation of calves from older stock, clean pastures, and drainage of low, swampy areas are more important than treatment in this condition.

RINGWORM

Ringworm is a fungous growth characterized by circular or ringlike areas which are scabby and practically free from hair, and increase in size as the infection spreads. This ailment is most troublesome in winter when calves are closely housed. The infected areas itch, are very irritating, and give the calf an unsightly appearance. Ringworm spreads rapidly, but can be checked by thoroughly cleaning and disinfecting the calf pens, and applying salicylic ointment or a good coal-tar or iodine ointment to the infected spots. Rub the ointment in thoroughly once each day until there is a considerable improvement, and then twice each week until the infection has disappeared. Do not miss any infected spots, and be sure to cover the entire surface of each affected area. Where space is available all affected animals should be isolated from those unaffected. Keep the pens clean so that reinfection will not occur.

WARTS

Warts are of common occurrence on calves and heifers, particularly during summer and autumn. They may occur in the skin of the head, neck, or other parts of the body. They are contagious or catching, and may spread over the body or to other animals unless steps are taken to check them. The daily application of castor oil is beneficial,

and should be made when the warts are first noted and are still small. In many cases the castor oil softens the warts to the extent that they are rubbed off by the animals' movements. If this does not remove the warts, tie a silk thread tightly around the wart near the base and allow the thread to remain until the wart drops off. Animals badly infected with warts should be isolated from the rest of the herd and the exposed stables and pens disinfected. Further information on the treatment and prevention of warts is contained in Department of Agriculture Leaflet 75, Warts on Cattle.

LICE

Lice are likely to infest calves, particularly in the winter when they are more closely housed. These lice irritate the calf's tender skin, give the calf an unthrifty appearance, and when large numbers are present keep it from gaining as it should.

If calves become infested with lice, you can control them with one of several insecticides. Rotenone, pyrethrum, DDT, methoxychlor, TDE, toxaphene, lindane, BHC, and chlordane may be used as sprays, but at present only rotenone, methoxychlor, and lindane are recommended for use as dusts. On heifers that will produce milk within 6 months use only rotenone, pyrethrum, methoxychlor, or lindane either as a spray or dust.

One thorough treatment with a spray will usually provide satisfactory control for several months, but a second treatment 14 to 18 days later may be necessary, especially if you use rotenone. In cold weather it may be advisable to use a dust because of the danger of chilling and pneumonia after spraying. If you use a dust, apply it liberally and rub it well into the animal's hair; repeat after 14 to 18 days.

For further information on how to use these insecticides see Leaflet 319, Control of Lice on Cattle.

FLIES

Several kinds of flies are particularly bothersome to young calves, especially in hot weather. They irritate the calf's tender skin, and the young animal is unable to brush them off.

Since the flies breed in manure, clean out the pens every few days. Scatter the manure to prevent the larvae from developing; do not throw it into a pile.

To protect newborn calves from bloodsucking flies, darken the pen and spray the walls and other surfaces with DDT, methoxychlor, lindane, or chlordane. After the calves are 2 or 3 weeks old, you can spray them with DDT, TDE, methoxychlor, or toxaphene to control horn flies. Pyrethrum sprays are more effective against stable flies, horse flies, and deer flies. Leaflet 283, Fly Control on Dairy Cattle and in Dairy Barns, will tell you how to prepare and use these sprays.

To prevent fly larvae from developing in the navel or wounds of calves, use the EQ-335 screwworm remedy or one of the other preparations recommended in circular E-813, entitled EQ-335 and Other Wound Treatments for Screwworm Control, issued by the Bureau of Entomology and Plant Quarantine.

TICKS

If your calves are infested with ticks, you can control them with a spray containing toxaphene or a mixture of DDT and lindane. The

Bureau of Entomology and Plant Quarantine tells you how to prepare and use these sprays in EC-10, New Sprays for Ticks on Livestock.

LEAD OR PAINT POISONING

Calves and heifers will eat paint from the walls of their pen or from any painted object or receptacle they can reach. Paint containing lead is poisonous, and if it is consumed in any appreciable quantity the animal usually dies.

This trouble can be prevented by whitewashing the walls or by using paint that does not contain any lead. Care should also be taken to keep all tools, implements, and utensils used in painting, away from cattle. Paint buckets especially should not be allowed around barns, lots, or pastures.

Billboards painted with lead paint are a source of lead poisoning, and are particularly dangerous when freshly painted. Billboards should not be erected in pastures or other places where cattle are kept unless an adequate fence is built to keep the cattle away.

BLACKLEG (BLACK QUARTER)

Blackleg is an acute infectious disease which attacks principally young cattle. It is caused by the bacillus of blackleg and is characterized by high body temperature, rapid breathing, stiff, painful movements, and hot muscular swellings over the body under the skin. The swellings give off a crackling sound when pressed which is due to gas formation under the skin. The onset of the disease is usually sudden, and the disease progresses rapidly to a fatal termination. Animals when first stricken may appear to be lame or suffering from severe bruises, and do not move with their usual activity.

Blackleg may appear at any time during the year, but spring and fall appear to be the most favorable seasons for its appearance, when it sometimes takes a heavy toll from unvaccinated young stock. Certain soils may become contaminated with the blackleg organism, and pastures on such soils may be unsafe for unvaccinated young animals. Annual burning-over of such land for several successive years is said to be an aid in destroying the infection.

Preventive vaccination of cattle 6 to 18 months of age, their most susceptible age, is a proved method of controlling this disease.

For further information see Farmers' Bulletin 1355, Blackleg, Its Nature, Cause, and Prevention.

HEMORRHAGIC SEPTICEMIA (SHIPPING FEVER)

Shipping fever is an acute infectious disease caused by the bacillus of hemorrhagic septicemia. It is characterized chiefly by swellings of the skin, associated with hemorrhages in the body tissues which may be superficial or deep-seated and it is usually attended by a very high rate of mortality. It may also take the form of pneumonia or dysentery, giving the appearance of a severe cold. The disease occurs in all species of domestic animals of any age at all seasons of the year. It is commonly observed in animals that have been recently transported or have been subjected to some sudden extreme of heat, cold, or exposure. In both older cattle and calves the disease may manifest itself at first by a high temperature and an excited or startled expression; the animal later develops labored breathing, swollen enlargements over the body, discharges from the eyes and nose, and rapid loss of flesh from severe, bloody bowel movements. Isolate such

affected animals immediately from other stock and place them in warm, dry, comfortable pens. Thoroughly clean and disinfect the stables and yards, as in outbreaks of other infectious diseases. A suitable disinfectant solution may be made by adding 4 ounces of liquor cresolis compositus (U. S. P.) or 6 ounces of carbolic acid to each gallon of water. This solution may be applied to pens and interiors of barns with a spray pump. For infected yards, a mixture of 5 ounces of copper sulfate to a gallon of water makes a suitable disinfectant solution.

As a precaution against introducing infection, it is a good plan to isolate all recently received or purchased animals for at least 2 weeks, and observe them for evidence of disease before allowing them to mingle with stock known to be healthy.

Suitable vaccination and curative treatment measures have been developed to combat the causative agent of hemorrhagic septicemia. For more detailed information concerning this disease, see Farmers' Bulletin 1018, Shipping Fever of Cattle, Hemorrhagic Septicemia.